William & Mary Environmental Law and Policy Review

Volume *47 (2022-2023)*
Issue 2

Article 2

1-2023

Environmental Assessment in a Time of Rapid Change and High Uncertainty: The Addition of Resilience Assessment to NEPA

Bronson J. Pace

Barbara A. Cosens

ENVIRONMENTAL ASSESSMENT IN A TIME OF RAPID CHANGE AND HIGH UNCERTAINTY: THE ADDITION OF RESILIENCE ASSESSMENT TO NEPA

BRONSON J. PACE* & BARBARA A. COSENS**

INTRODUCTION

Professor James Hansen, former head of NASA's Goddard Institute for Space Studies and professor at Columbia University's Earth Institute, formed an international team of scientists to research the connection among atmospheric CO_2 concentrations and global temperature and set out to provide model projections based on that research.[1] The Hansen team is a counterpart to the concurrent science produced by the United Nations Intergovernmental Panel on Climate Change ("IPCC").[2] In its Fifth Assessment in 2014, the IPCC Working Group concluded that without efforts to reduce anthropogenic greenhouse gas emissions, atmospheric concentrations will at their baseline exceed 850 parts per million ("ppm") by 2100.[3] In its Sixth Assessment in 2021, the IPCC estimated a rise in global temperature of between 6.3 degrees and 13.3 degrees Fahrenheit, with a high probability of an increase of 9.4 degrees Fahrenheit by 2100.[4] In turn, the IPCC projected that such CO_2 levels implicate

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* JD/PhD, Environmental Planner at EMPSi: Environmental Management and Planning Solutions, Inc. This Article is a product of the lead author's dissertation: *It's About Time: A Sociolegal Approach to Intergenerational Climate Justice in the United States, with Developments in Environmental Justice Scholarship, Climate Change Litigation, and Climate Adaptation Law*, December 2021, University of Idaho, Water Resources Program.
** University Distinguished Professor Emerita, University of Idaho College of Law.

[1] *See* Juliana v. United States, 217 F. Supp. 3d 1224, 1233, 1252 n.8 (D. Or. 2016).

[2] Dana Nuccitelli, *30 Years Later, Deniers Are Still Lying About Hansen's Amazing Global Warming Prediction*, GUARDIAN (June 25, 2018, 6:00 AM), https://www.theguardian.com/environment/climate-consensus-97-per-cent/2018/jun/25/30-years-later-deniers-are-still-lying-about-hansens-amazing-global-warming-prediction [https://perma.cc/FU69-DZX6].

[3] *See* IPCC, CLIMATE CHANGE 2014 SYNTHESIS REPORT SUMMARY FOR POLICYMAKERS 18–19 (The Core Writing Team, Rajendra K. Pachauri & Leo Meyer eds., 2014), https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf [https://perma.cc/8T7Y-53MU].

[4] *See* IPCC, CLIMATE CHANGE 2021 SUMMARY FOR POLICYMAKERS 14 (2021), https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf [https://perma.cc/FCL8-CZC7].

an increase of global temperature well above the threshold sufficient to initiate a runaway greenhouse effect.[5]

While the IPCC focused on the overall temperature increase—applying a stringent mitigation scenario to keep warming under two degrees Celsius—the Hansen team took a slightly different approach.[6] The Hansen team focused on exploring the connection among atmospheric CO_2 concentrations and the stable state of Earth's energy.[7] The Hansen team likewise concluded that the global climate is reaching a dangerous ecological threshold which, if reached, will trigger positive feedback processes that will unleash an irreversible heating trend capable of shifting the balance of Earth's climate system to a state uninhabitable by humans.[8]

Despite the call for mitigation in the 2022 Sixth Assessment Report of the IPCC, there is also an acknowledgment that Earth is already down the path of change that will require climate adaptation. The report defines adaptation in this context as: "Adaptation, in response to current climate change, is reducing climate risks and vulnerability mostly via adjustment of existing systems. Many adaptation options exist and are used to help manage projected climate change impacts, but their implementation depends upon the capacity and effectiveness of governance and decision-making processes."[9]

While climate mitigation calls for global measures to reduce the emission of greenhouse gases, adaptation to those changes that nevertheless occur requires measures that are contextual—but not just contextual. Adaptation measures must be implemented in the face of uncertainty as to the continuing effects of climate change and the response of the local environment to the adaptation measures themselves.

In the United States, adaptation measures are also likely to require substantial federal resources.[10] By law, "major Federal actions significantly

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[5] *See, e.g.*, *id.* at 21.

[6] *Compare id.* at 27, *with* JAMES HANSEN, PUSHKER KHARECHA, MAKIKO SATO, PAUL EPSTEIN, PAUL J. HEARTY, OVE HOEGH-GULDBERG, CAMILLE PARMESAN, STEFAN RAHMSTORF, JOHAN ROCKSTROM, EELCO J. ROHLING, JEFFREY SACHS, PETER SMITH, KONRAD STEFFEN, KARINA VON SCHUCKMANN & JAMES C. ZACHOS, THE CASE FOR YOUNG PEOPLE AND NATURE: A PATH TO A HEALTHY, NATURAL, PROSPEROUS FUTURE 1 (2011), http://www.columbia.edu/~jeh1/mailings/2011/20110505_CaseForYoungPeople.pdf [https://perma.cc/QT76-2YE4].

[7] *See* HANSEN ET AL., *supra* note 6, at 1, 4.

[8] *Id.* at 5.

[9] IPCC, CLIMATE CHANGE 2022 SUMMARY FOR POLICYMAKERS 20 (2022), https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf [https://perma.cc/MPG6-9GS7].

[10] *Cf. id.*

affecting the quality of the human environment" require an Environmental Impact Statement ("EIS").[11] Federal involvement in climate adaptation invokes this requirement. EISs are one-time, upfront assessments of the impact of a proposed action.[12] Despite literature identifying avenues within the National Environmental Policy Act ("NEPA") as well as federal land management statutes for addressing uncertainty through use of adaptive management,[13] the process remains inadequate for situations of high uncertainty and ongoing change from external factors. It does not account for the emergent behavior, including nonlinear behavior as an ecosystem or a socioecological system ("SES")[14] undergoing nonlinear change as it passes a tipping point. Public input occurs during the pre-implementation EIS process, and the opportunity for judicial review occurs when the EIS is completed but still before the project begins.[15] Agency approaches to NEPA when using adaptive management include a supplemental NEPA analysis when an adjustment is made,[16] identification of potential adjustments in the initial EIS,[17] and use of adaptive management in the context of mitigating measures to avoid an EIS altogether.[18] In a rapidly changing system with increasing amplitude of variability

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[11] National Environmental Policy Act ("NEPA"), 42 U.S.C. § 4332(2)(C).
[12] *Id.*
[13] *See* Robert L. Glicksman & Jarryd Page, *Adaptive Management and NEPA: How to Reconcile Predictive Assessment in the Face of Uncertainty with Natural Resource Management Flexibility and Success*, 46 HARV. ENV'T L. REV. 121, 122–23 (2021); J.B. Ruhl & Robert L. Fischman, *Adaptive Management in the Courts*, 95 MINN. L. REV. 424, 424 (2010); Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L.J. 1, 1, 7 (2009).
[14] *See* Klaus Krumme, *Sustainable Development and Social-Ecological-Technological Systems (SETS): Resilience as a Guiding Principle in the Urban-Industrial Nexus*, 2 J. RENEWABLE ENERGY & SUSTAINABLE DEV. 70, 81 (2016) (defining "SETs" as interacting natural and human systems in which the technological component represents the increasingly complex realm of interaction between the human and natural systems); *see also* Barbara Cosens, J.B. Ruhl, Niko Soininen & Lance Gunderson, *Designing Law to Enable Adaptive Governance of Modern Wicked Problems*, 73 VAND. L. REV. 1687, 1721 (2020) [hereinafter Cosens et al., *Designing Law*]; Barbara A. Cosens, J.B. Ruhl, Niko Soininen, Lance Gunderson, Antti Belinskij, Thorsten Blenckner, Alejandro E. Camacho, Brian C. Chaffin, Robin Kundis Craig, Holly Doremus, Robert Glicksman, Anna-Stiina Heiskanen, Rhett Larson & Jukka Similä, *Governing Complexity: Integrating Science, Governance, and Law to Manage Accelerating Change in the Globalized Commons*, 118 PNAS, no. 36, 2021, at 1, 1 [hereinafter Cosens et al., *Governing Complexity*].
[15] 5 U.S.C. § 704 ("Agency action made reviewable by statute and final agency action for which there is no other adequate remedy in a court are subject to judicial review.").
[16] Glicksman & Page, *supra* note 13, at 141 (referring to the National Park Service).
[17] *Id.* at 147–51 (referring to the U.S. Forest Service).
[18] *Id.* at 136 (referring to the Council on Environmental Quality guidance).

and the potential for nonlinear shifts, this approach is insufficient and will hinder the capacity of communities to adapt to climate change.

This Article turns to ecological resilience theory to understand the behavior of SES undergoing change. Informed by the emergent and surprising behavior of these complex systems, this Article argues for the option of resilience assessment under NEPA for use in application to climate adaptation measures in the United States. The amendment also provides an alternative approach to pre-project judicial review to ensure legitimacy within a more flexible process.

To this end, Part I addresses *why* an alternative approach to environmental assessment is needed in the context of climate adaptation by providing an overview of the dynamics of complex SES understood through the lens of resilience theory. Part II addresses *what* type of assessment is needed in situations of high uncertainty and ongoing change by introducing resilience assessment as a means to understand change in complex SES and to identify, measure, and ultimately enhance the adaptive capacity of rising and future generations. Part III addresses *how* resilience assessment can be used in agency programs and decision-making under NEPA, including model amendments. Climate mitigation is essential, but many aspects are technology-related and lend themselves to traditional NEPA review, whether expedited or not. In contrast, climate adaptation requires management of complex SES facing change that includes sea level rise, changing wildfire regimes, greater extremes in flood and drought, changes in water supply and timing, and increasing temperature extremes. System response will be contextual, potentially nonlinear, with high levels of uncertainty. As a result, climate adaptation must focus on measures that build long-term adaptive capacity rather than short-term results. This Article addresses the why, what, and how this may be facilitated through NEPA.

I. THE DYNAMICS OF COMPLEX SOCIAL-ECOLOGICAL SYSTEMS

Systems thinking and complexity theory grew out of the recognition in the twentieth century that living systems have emergent properties that cannot be understood by study of the system components in isolation.[19] Instead, research in these areas began to focus on the interaction

[19] *See* LUDWIG VON BERTALANFFY, GENERAL SYSTEM THEORY: FOUNDATIONS, DEVELOPMENT, APPLICATIONS 3–5 (1968) (describing the early development of mathematical models to understand complex systems and considered the beginning of complexity theory); Ralph

among system components.[20] Ecological resilience theory emerged out of this revolution in knowledge production concerning the behavior of complex systems.[21] Understanding why a different approach to assessment is critical in consideration of the impacts of climate adaptation measures on the environment requires understanding how complex systems behave when disturbed by external drivers of change. The following sections will briefly discuss the theory that explains the emergent behavior of ecosystems: resilience, the application of that theory to integrated social-ecological systems, and the types of surprising behavior that may occur when a SES is disturbed.

A. The Emergence of Ecological Resilience Theory

Ecologist C.S. Holling first coined the phrase "ecological resilience" in 1973, by applying systems theory to the interaction of components of ecosystems.[22] He described "resilience" as the amount of disturbance that an ecosystem can withstand without shifting into an alternative stable state.[23] Holling observed that an ecosystem's ability to *withstand* is not limited to resistance to a threshold and shift to a new state, but that these systems self-organize to adapt and, thus, an ecosystem has the potential to withstand a shift to an alternative state through both resistance and adaptation.[24] Over time, this observation enabled a novel understanding

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H. Abraham, *The Genesis of Complexity*, 67 WORLD FUTURES 380, 380–84 (2011) (detailing the roots of complexity theory); *see also* JOHN H. MILLER & SCOTT E. PAGE, COMPLEX ADAPTIVE SYSTEMS: AN INTRODUCTION TO COMPUTATIONAL MODELS OF SOCIAL LIFE 23–24 (2007); Nicholas W. Watkins & Mervyn P. Freeman, *Natural Complexity*, 320 SCIENCE 323, 324 (2008). *See generally* FRITJOF CAPRA & PIER LUIGI LUISI, THE SYSTEMS VIEW OF LIFE: A UNIFYING VISION 1–12 (2014) (discussing the development of systems thinking). For a more in-depth discussion of how systems thinking and complexity theory inform governance, see generally Cosens et al., *Designing Law*, *supra* note 14.

[20] Abraham, *supra* note 19, at 384–88.

[21] Lance H. Gunderson, *Ecological Resilience—In Theory and Application*, 31 ANN. REV. ECOLOGY & SYSTEMATICS 425, 430, 432 (2000).

[22] C.S. Holling, *Resilience and Stability of Ecological Systems*, 4 ANN. REV. ECOLOGY & SYSTEMATICS 1, 18 (1973).

[23] *Id.* at 20 (explaining the core concept of "multiple basins of attraction"—i.e., that ecosystems may fluctuate substantially while persisting in the same basic structure and function). Holling also described resilience as "the amount of external pressure that is needed to bring about a given amount of disturbance in the system." Steve Carpenter, Brian Walker, J. Marty Anderies & Nick Abel, *From Metaphor to Measurement: Resilience of What to What?*, 4 ECOSYSTEMS 765, 766 (2001).

[24] C.S. Holling, *Engineering Resilience Versus Ecological Resilience*, *in* ENGINEERING WITHIN ECOLOGICAL CONSTRAINTS 31–43 (Peter C. Schulze ed., 1996).

that ecosystems move through a process of self-organization in which the capacity of a system to sustain growth declines as it matures and other processes interact that may either promote or reduce adaptive capacity.[25] Importantly, ecological resilience theory describes system properties.[26] It does not use "resilience" as a normative term, thus recognizing that a system's resistance to change may be good or bad.[27]

By 1986, Holling's resilience perspective was developed into a conceptual model of an "adaptive cycle" (see Figure 1).[28] This visual metaphor describes the pattern of how SES respond to disturbances and rapid change and behave across time.[29] The adaptive cycle is based on four phases in system dynamics: (1) *exploitation*—in which systems have ample resources to respond dynamically to unexpected disturbances; (2) *conservation*—in which systems become more efficient but less adaptable to unexpected disturbances as they approach thresholds; (3) *release*—in which established functions are destroyed following the crossing of a threshold; and (4) *reorganization*—in which new structures and thresholds are then established.[30]

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[25] C.S. Holling, *The Resilience of Terrestrial Ecosystems: Local Surprise and Global Change*, *in* FOUNDATIONS OF ECOLOGICAL SYSTEMS 67–109 (Lance H. Gunderson, Craig Reece Allen & C.S. Holling eds., 2009).
[26] *Id.* at 72.
[27] *Id.*
[28] *Id.* at 95 fig.5.
[29] *See id.*
[30] Wolfgang zu Castell & Hannah Schrenk, *Computing the Adaptive Cycle*, 10 SCI. REPS., 2020, at 1, 1.

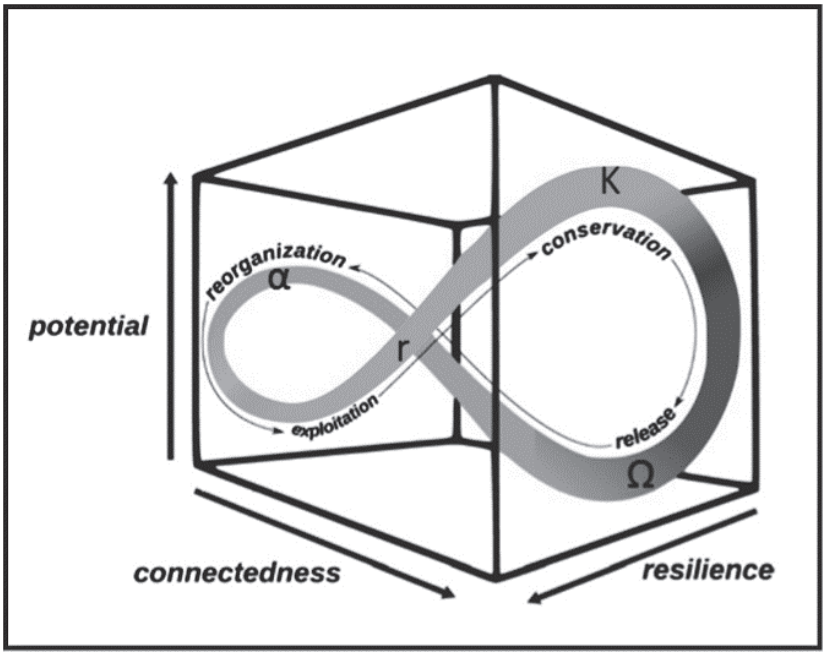

Figure 1. A depiction of the adaptive cycle metaphor. The *release* and *reorganization* phases are fast and unpredictable and are critical to determining a SES trajectory. Three dimensions define the phases: (1) *potential*, or the range of accumulated resources; (2) *connectedness*, or the degree of connection between variables and internal controlling processes; and (3) *resilience*, or the amount of disturbance that a system can withstand before crossing a threshold into an alternative stable state.[31]

The concept of "panarchy" was developed in the early 2000s, and it added critical insight to the adaptive cycle metaphor by explaining how the processes of ecological systems extend across both space and time as nested, interacting sets of adaptive cycles.[32] In other words, each SES experiences the adaptive cycle on different spatial and temporal scales,

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[31] *Id.* at 2 fig.1.

[32] *See generally* C.S. Holling, Lance H. Gunderson & Donald Ludwig, *In Quest of a Theory of Adaptive Change*, *in* PANARCHY: UNDERSTANDING TRANSFORMATIONS IN HUMAN AND NATURAL SYSTEMS 3, 5 (Lance H. Gunderson & C.S. Holling eds., 2002) [hereinafter PANARCHY] (explaining that natural systems are linked together forming a hierarchical structure of adaptive cycles of growth, accumulation, restructuring, and renewal).

where each scale contains its own structures and functions, but it also influences, and is influenced by, processes occurring on other scales.[33] One of the most important aspects of panarchy is that external input or internal innovation can cause a system to skip a phase, or return to a prior, or entirely transform to an alternative system state.[34]

B. The Application of Resilience Theory to Social-Ecological Systems

Nobel laureate Elinor Ostrom observed that communities reliant on a common pool resource will, under certain conditions, self-organize to sustain the resource.[35] The combined recognition that local self-organization appeared to be more adaptable to changing resource conditions and the existence of emergent behavior (self-organization to accomplish what the community could not do alone) catalyzed the uptake of resilience theory in the social sciences in application to SES.[36] It also led to an effort to

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[33] *See* Brian Walker & David Salt, *In the Loop: Phases, Cycles, and Scales-Adaptive Cycles and How Systems Change*, *in* RESILIENCE THINKING: SUSTAINING ECOSYSTEMS AND PEOPLE IN A CHANGING WORLD 74, 91–92 (2012) (explaining that systems on a lower scale can trigger a crisis towards a release phase on a higher scale, and the systems on a higher scale may shape dynamics on a lower scale).

[34] PANARCHY, *supra* note 32.

[35] *See generally* ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 26–27 (James E. Alt & Douglass C. North eds., 1990) (demonstrating that the "tragedy of the commons" is not inevitable and documenting numerous examples of community self-organization). For an excellent article on the history of Ostrom's work on social-ecological systems and self-organization, see Fabien Locher, *Historicizing Elinor Ostrom: Urban Politics, International Development and Expertise in the U.S. Context (1970–1990)*, 19 THEORETICAL INQUIRIES L. 533, 543 (2018). "Common pool resources . . . are characterized as resources for which the exclusion of users is difficult (referred to as excludability), and the use of such a resource by one user decreases resource benefits for other users (referred to as subtractability)." Tanya Heikklia & David P. Carter, *Common Pool Resources*, OXFORD BIBLIOGRAPHIES ONLINE, https://www.oxfordbibliographies.com/view/document/obo-9780199363445/obo-9780199363445-0011.xml [https://perma.cc/Y2WK-6MLR] (Oct. 25, 2017). Common pool resources include air, water, soils, forests, rangelands, fisheries, and oceans. *Id.*

[36] Carl Folke, *Resilience*, 21 ECOLOGY & SOC'Y, no. 4, Dec. 2016, at 1, 3–4. Substantial debate exists within the social science community around the strict application of resilience theory to human behavior due to its failure to account for attributes such as agency and power. *See, e.g.*, Debra J. Davidson, *The Applicability of the Concept of Resilience to Social Systems: Some Sources of Optimism and Nagging Doubts*, 23 SOC'Y & NAT. RES. 1135, 1143–45 (2010). Co-author Cosens, along with other scholars, argue that an understanding of system behavior through the lens of resilience is nevertheless useful to management of SES. Cosens et al., *Designing Law*, *supra* note 14, at 1726–27.

identify the institutional conditions (referred to as "adaptive governance") under which self-organization will emerge.[37] Importantly, recent research has looked at the role of government in facilitating emergence of adaptive governance, building local capacity to self-organize, and steering adaptive governance to enhance legitimacy, accountability, equity, and justice.[38] Application of the concept of panarchy to SES governance provides a useful illustration of how intervention from a higher scale (e.g., the federal government) or innovation from a smaller scale (e.g., local governments and stakeholders) can alter the trajectory of a SES to a more desirable state.[39]

Attributes of complex systems that must be considered in any effort to adapt in the face of change include: "(1) self-organization; (2) emergence; (3) networks; (4) feedback; (5) nonlinearity and tipping points; (6) cross-scale interactions; and (7) uncertainty."[40] These attributes are particularly difficult for legal systems that seek to foster stability in social and economic systems. The new challenge, however, is to maintain measured stability in the face of external drivers of change. Climate change will destabilize communities without attention to adaptation.[41]

SES resilience theory is not only a useful conceptual framework that improves the understanding of how intertwined SES experience dynamic change, but it also underscores the importance of taking anticipatory actions to identify the trajectory of a SES that might signal the approach of a threshold.[42] The main takeaway here is that this understanding of

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[37] Thomas Dietz, Elinor Ostrom & Paul C. Stern, *The Struggle to Govern the Commons*, 302 SCIENCE 1907, 1910 (2003). For a review of the literature on adaptive governance that unpacks the role of formal institutions (i.e., government) in adaptive governance, see Cosens et al., *Designing Law*, *supra* note 14, at 1727.

[38] Cosens et al., *Designing Law*, *supra* note 14, at 1711–12; Cosens et al., *Governing Complexity*, *supra* note 14, at 5; Barbara A. Cosens, Robin K. Craig, Shana Lee Hirsch, Craig Anthony (Tony) Arnold, Melinda H. Benson, Daniel A. DeCaro, Ahjond S. Garmestani, Hannah Gosnell, J.B. Ruhl & Edella Schlager, *The Role of Law in Adaptive Governance*, 22 ECOLOGY & SOC'Y, no. 1, 2018, at 1, 7 [hereinafter Cosens et al., *The Role of Law*], https://www.ecologyandsociety.org/vol22/iss1/art30/ [https://perma.cc/B358-TDRT].

[39] Brian C. Chaffin & Lance Gunderson, *Emergence, Institutionalization and Renewal: Rhythms of Adaptive Governance in Complex Social-Ecological Systems*, 165 J. ENV'T MGMT. 81, 83–84 (2016).

[40] Cosens et al., *Designing Law*, *supra* note 14, at 1699.

[41] MOHAMED EL-ASHRY, U.N. FOUND., ADAPTATION TO CLIMATE CHANGE: BUILDING RESILIENCE AND REDUCING VULNERABILITY 58–59 (2009).

[42] Mark Andrachuck & Derek Armitage, *Understanding Social-Ecological Change and Transformations Through Community Perceptions of System Identity*, 20 ECOLOGY & SOC'Y, no. 4, 2015, at 1, 25–26, https://ecologyandsociety.org/vol20/iss4/art26/ [https://perma.cc/8XLY-SENS].

complex systems, including the benefits and harms that could result from crossing a threshold, can be used to redirect and navigate toward a more desirable system state—all while managing the shift by enhancing the adaptive capacity for those most vulnerable among the rising and future generations.[43]

C. The Surprising Behavior of Complex Systems Undergoing Change

Complex systems undergoing change from external disturbance exhibit both adaptive and nonlinear (i.e., transformative) behavior, placing high uncertainty on the outcome of both the disturbance and any human intervention. The metaphor of the bowl and the ball, as illustrated by Sommerkorn et al., helps explain this phenomenon popularized in the concept of tipping points.[44] As shown in Figure 2, if a system crosses the threshold or tipping point, it reorganizes into a different state.[45] Resistance is depicted as the depth of the bowl and adaptive capacity as the width.[46] Engineered solutions such as sea walls for rising storm surge and levees for increased flood amplitude enhance resistance, thus moving the system farther from a threshold. As shown in Figure 1, this may also come at the expense of adaptive capacity by locking in an optimized trajectory. Should climate change shift the system farther than predicted, little capacity remains to address this surprise. Thus, in situations of high uncertainty, increasing adaptive capacity is critical. It should also be noted that in some climate change scenarios, crossing a threshold is inevitable. Navigating transformation without substantial social disruption is also served by the capacity of the social system to adapt.

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[43] Gunderson, *supra* note 21, at 432–436; Carl Folke, Thomas Hahn, Pier Olsson & Jon Norberg, *Adaptive Governance of Social-Ecological Systems*, 30 ANN. REV. ENV'T RES. 441, 455–56 (2005).

[44] MALCOM GLADWELL, THE TIPPING POINT: HOW LITTLE THINGS CAN MAKE A BIG DIFFERENCE 7–9 (2002).

[45] Silvia Serrao-Neumann, Julie L. Davidson, Claudia L. Baldwin, Aysin Dedekorkut-Howes, Joanna C. Ellison, Neil J. Holbrook, Michael Howes, Christine Jacobson & Edward A. Morgan, *Marine Governance to Avoid Tipping Points: Can We Adapt the Adaptability Envelope?*, 65 MARINE POL'Y, 56, 62–63 (2016).

[46] Martin Sommerkorn, Sarah Cornell, Annika E. Nilsson, Cathy Wilkinson, Martin Robards, Tatiana Vlasova & Allyson Quinlan, *A Resilience Approach to Social-Ecological Systems: Central Concepts and Concerns*, *in* ARCTIC RESILIENCE INTERIM REPORT 2013, at 15, 15–16 (2013).

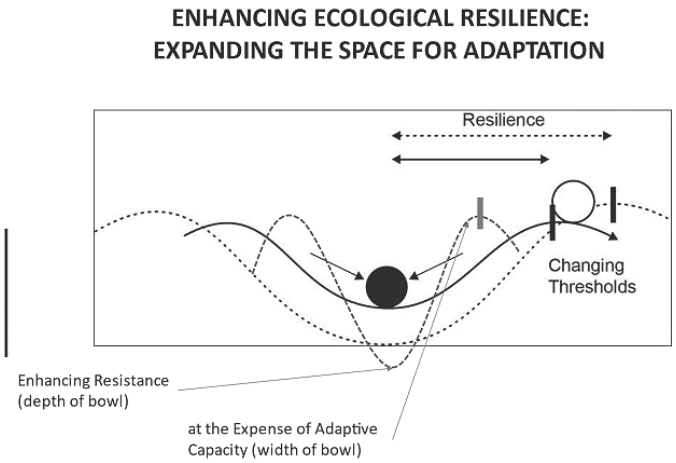

Figure 2. Source: modified from Martin Sommerkorn, Sarah Cornell, Annika E. Nilsson, Cathy Wilkinson, Martin Robards, Tatiana Vlasova and Allyson Quinlan, A Resilience Approach to Social-Ecological Systems: Central Concepts and Concerns, Chapter 2 in Arctic Resilience Interim Report 2013, Arctic Council, *available at* https://oaarchive.arctic-council.org/handle/11374/1628.

In addition to nonlinear change, complex systems may have a cascading response to external disturbance due to positive feedbacks.[47] A positive feedback loop is one that reinforces itself along a trajectory of increasing change.[48] A negative feedback loop is one that slows change helping the system maintain stasis.[49] For example, clouds reflect sunlight back into space.[50] In a warming climate, more water is absorbed into the atmosphere, creating more clouds, and slowing warming.[51] This is a

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[47] B. Buma, *Disturbance Interactions: Characterization, Prediction, and the Potential for Cascading Effects*, ECOSPHERE, Apr. 2015, at 1, 8–9.
[48] Steve Daniels, *What Algae Taught Me About Resilience*, MEDIUM (Apr. 14, 2021), https://medium.com/mind-cafe/what-algae-taught-me-about-resilience-ee814cf7bce [https://perma.cc/RAW2-8TUH].
[49] *Id.*
[50] Martin King, *Oxidation of Organic Films on Cloud Droplets*, UKRI: SCI. & TECH. FACILITIES COUNCIL (Dec. 2008), https://www.isis.stfc.ac.uk/Pages/Oxidation-of-organic-films-on-cloud-droplets.aspx [https://perma.cc/7RTL-W4L3].
[51] NASA, *The Study of Earth as an Integrated System*, GLOB. CLIMATE CHANGE PROJECT, https://climate.nasa.gov/nasa_science/science/ [https://perma.cc/PCT6-ABL7] (last visited Jan. 16, 2023).

negative feedback loop. In contrast, oceans absorb heat from the sun whereas ice is highly reflective.[52] As temperatures rise, ice melts exposing more ocean surface, temperature rises even faster.[53] This is a positive feedback loop.[54] Of importance to climate adaptation is the fact that positive feedback loops can result in rapid, surprising, cascading change, overwhelming solutions identified through an initial analysis that does not track and adapt to continuing change.

Legal systems seek to foster stability in social and economic systems.[55] Thus for example, NEPA analysis provides certainty and finality by providing upfront final review that focuses legal challenges on the preproject stage. This approach, however, is problematic when the drivers of change are external, biophysical, inevitable, and ongoing aspects of the system. The new challenge is to maintain measured stability in the face of external drivers of change. Climate change is likely to destabilize communities that have not given attention to adaptive capacity. The next part explores an approach that may allow consideration of ongoing change while providing measured stability within the context of NEPA assessment.

II. THE CASE FOR RESILIENCE ASSESSMENT IN CLIMATE ADAPTATION INITIATIVES

The speed, high uncertainty, and potential for surprising, nonlinear, and cascading change calls for a new approach to environmental assessment that does not depend on a static, or at least predictable, system. This Part addresses what type of assessment is better suited to climate adaptation. The following sections will explore a new form of assessment referred to as "resilience assessment" developed specifically for situations of high uncertainty in which the capacity of a SES to adapt to change is critical[56] and will also explore the tools developed to apply it.

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[52] *Id.*

[53] *Climate and Ice*, UCAR CTR. FOR SCI. EDUC., https://scied.ucar.edu/learning-zone/climate-change-impacts/climate-and-ice [https://perma.cc/EY5E-CJWB] (last visited Jan. 16, 2023).

[54] For a good primer on feedback loops in climate change scenarios, see NASA, *supra* note 51.

[55] Robin Kundis Craig, Ahjond S. Garmestani, Craig R. Allen, Craig Anthony (Tony) Arnold, Hannah Birgé, Daniel A. DeCaro, Alexander K. Fremier, Hannah Gosnell & Edella Schlager, *Balancing Stability and Flexibility in Adaptive Governance: An Analysis of Tools Available in U.S. Environmental Law*, 22 ECOLOGY & SOC'Y, no. 2, 2017, at 1, 2, 5, https://www.ecologyandsociety.org/vol22/iss2/art3/ [https://perma.cc/3UU9-TC6R].

[56] David A. Kerner & J. Scott Thomas, *Resilience Attributes of Social-Ecological Systems: Framing Metrics for Management*, 3 RESOURCES 672, 674 (2014).

A. Defining Resilience Assessment and Its Application

A resilience assessment is a procedural analysis of the past, current, and potential future system dynamics associated with each unique and interconnected SES.[57] Co-produced with stakeholders within a focal system, and framed within the adaptive cycle and panarchy metaphors, a resilience assessment builds knowledge of nonlinear SES dynamics, interactions across temporal and spatial scales, thresholds of concern, adaptive capacity, and decision-making in the face of uncertainty.[58] A resilience assessment not only helps stakeholders identify the key components and variables that define the system state and its position within the adaptive cycle, but it also identifies the environmental and social impacts of disturbances, the amount of change that a system can undergo, the degree to which a system is capable of self-organization, and the degree to which a system can build adaptive capacity.[59]

Resilience assessment explores alternative option spaces by considering plausible future trajectories that may lead to innovative management strategies and are intended to either maintain the current system state or spur an intentional transformation.[60] When developed in collaboration with stakeholders, it can be a tool for a two-way flow of information.

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[57] Referring to the adaptive cycle and panarchy metaphor, advanced by developing timelines based on past disturbances, considering cross-scale interactions, and consolidating the socioecological problems. *See* 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, no. 1, 2006, at 1, 2–3, http://www.ecologyandsociety.org/vol11/iss1/art19/ [https://perma.cc/82QH-5836].

[58] Folke, *supra* note 36, at 3, 11; Allyson Quinlan, Marta Berbés-Blázquez, L. Jamila Haider & Garry D. Peterson, *Measuring and Assessing Resilience: Broadening Understanding Through Multiple Disciplinary Perspectives*, 53 J. APPLIED ECOLOGY 677, 683 (2016) (describing pathways and identifying those that are robust to shocks, disturbances, and other drivers of change).

[59] BRIAN WALKER, ALLYSON QUINLAN, GEORGINA CUNDILL & COLIN BEIER, RESILIENCE ALL., ASSESSING RESILIENCE IN SOCIAL-ECOLOGICAL SYSTEMS: WORKBOOK FOR PRACTITIONERS 4–5 (2d version 2010). A resilience assessment "integrates a set of key concepts to provide an alternative way of thinking about and practicing natural resource management." *Id.* at 4.

[60] Michele-Lee Moore, Ola Tjornbo, Elin Enfors, Corrie Knapp, Jennifer Hodbod, Jacopo A. Baggio, Albert Norström, Per Olsson & Duan Biggs, *Studying the Complexity of Change: Toward an Analytical Framework for Understanding Deliberate Social-Ecological Transformations*, 19 ECOLOGY & SOC'Y, no. 4, 2017, at 1, 2–3, http://dx.doi.org/10.5751/ES-06966-190454 [https://perma.cc/Q3XE-T4RW].

Local knowledge is generally the first to identify emergent properties in complex systems.[61] At the same time science from government agencies and/or research institutions helps build local capacity regarding the problem and the options going forward.[62]

Resilience assessment is not suggested as a wholesale replacement for other forms of environmental assessment but as an approach that is particularly suited to certain situations. While resilience assessment may be used anytime there is a need to understand how a SES works and how it will develop dynamically over time through the processes of adaptation and transformation, but has generally risen in use with regards to systems undergoing change.[63] A resilience assessment can be used when anticipating events of accelerating change and uncertainty, to more fully understand the external factors that influence the system, the internal variables that change with the system, and the specific time characteristics involved in approaching system thresholds.[64] A resilience assessment can also be used during a time of crisis or emergency when a SES is experiencing a pathway of growth and lacks the adequate supply of external resources.[65] Moreover, it can be used anytime there is a value and goal to sustain or improve the adaptive capacity of a SES to lessen harms and provide benefits to current and future society.[66] Because of its relevance to situations of change and high uncertainty, and its role in building local capacity simply through participation in the assessment process, it seems particularly suited to the assessment of climate adaptation measures.

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[61] Mengistu Asmamaw, Seid Tiku Mereta & Argaw Ambelu, *The Role of Local Knowledge in Enhancing the Resilience of Dinki Watershed Social-Ecological System, Central Highlands of Ethiopia*, PLOS ONE, Sept. 2020, at 1, 3, 9.

[62] *See* Lebel et al., *supra* note 57, at 5, 7.

[63] Brian Walker, Stephen Carpenter, John Anderies, Nick Abel, Graeme Cumming, Marco Janssen, Louis Lebel, Jon Norberg, Garry D. Peterson & Rusty Pritchard, *Resilience Management in Social-Ecological Systems: A Working Hypothesis for a Participatory Approach*, 6 ECOLOGY & SOC'Y, no. 1, 2006, at 1, 2, https://www.ecologyandsociety.org/vol6/iss1/art14/ [https://perma.cc/VWY5-9LT9].

[64] *See* WAYFINDER: A RESILIENCE GUIDE FOR NAVIGATING TOWARDS SUSTAINABLE FUTURES [hereinafter WAYFINDER], https://wayfinder.earth/ [https://perma.cc/593H-G8S9] (last visited Jan. 16, 2023).

[65] F. Stuart Chapin, III, Carl Folke & Gary P. Kofinas, *A Framework for Understanding Change*, *in* PRINCIPLES OF ECOSYSTEM STEWARDSHIP: RESILIENCE-BASED NATURAL RESOURCE MANAGEMENT IN A CHANGING WORLD 3, 25 (F. Stuart Chapin, III, Gary P. Kofinas & Carl Folke eds., 2009) (presenting a framework for managing ecosystems for ecological integrity and human well-being while embracing uncertainty and change).

[66] WALKER ET AL., *supra* note 59, at 4.

B. Applied Resilience Assessment

There are numerous approaches to resilience assessment.[67] For a user-friendly process that contemplates the involvement of stakeholders, the Stockholm Resilience Center provides a comprehensive resilience assessment tool in its interactive guide: *Wayfinder: A Resilience Guide for Navigating Toward Sustainable Futures*.[68] *Wayfinder* is a collaborative process with a generic approach to help stakeholders assess various types of SESs.[69] It contains a five step process, which can be summarized as follows: (1) assemble a team to design principles for engagement with interested stakeholder groups; (2) frame the process by identifying the aspirations, dilemmas, and key social and ecological components; (3) assess the system by creating a model of SES dynamics, cross-scale interactions, feedbacks, thresholds, and plausible future trajectories; (4) plan for the future by designing innovative strategies for change; (5) move into action through a learning-by-doing approach to test the strategic plan and to continually refine it.[70]

The Resilience Alliance developed a similar approach to resilience assessments, by using a workbook with strategic questions and activities, titled: *Assessing Resilience in Social-Ecological Systems: Workbook for Practitioners*.[71] This issue-based approach is an iterative process that focuses on designing a conceptual model of the focal SES, which encapsulates "resources, stakeholders, institutions, and issues," and identifies "potential *thresholds* . . . between . . . alternative system states" in order to provide insight into factors that "contribut[e] to or erod[e] system resilience."[72] Similar to *Wayfinder*, the assessment includes five main steps: (1) stakeholders describe the system; (2) they develop understanding of system dynamics; (3) they probe system interactions; (4) they evaluate governance; and (5) they act on the assessment.[73] The workbook

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[67] *See, e.g.*, David G. Angeler & Craig R. Allen, *Quantifying Resilience*, 53 J. APPLIED ECOLOGY 617, 621 (2016).
[68] *See* WAYFINDER, *supra* note 64; *see* Elin Enfors-Kautsky, Linn Jarnberg, Allyson Quinlan & Paul Ryan, *Wayfinder: A New Generation of Resilience Practice*, 26 ECOLOGY & SOC'Y, no. 2, 2021, at 1, 3–12, https://www.ecologyandsociety.org/vol26/iss2/art39/ [https://perma.cc/W9C6-CJKT].
[69] WAYFINDER, *supra* note 64.
[70] *Id.*
[71] WALKER ET AL., *supra* note 59, at 4.
[72] *Id.*
[73] *Id.* at 5 fig.1.

emphasizes how each assessment is unique and that each step requires referring back to earlier steps and revising as necessary.[74]

Both *Wayfinder* and the Resilience Alliance workbook highlight five essential inquires that are applicable to any resilience assessment, namely: (1) who needs to be in the room; (2) what data, information, and local knowledge is used; (3) how are the goals set; (4) what types of scenarios should be explored, including how should decision makers deal with uncertainty; and (5) what do the outcomes look like, and are they updated?[75] The following subsections respond in a way that is intended to view each of these questions in the context of climate adaptation.

1. Who Needs to Be in the Room?

Since a resilience assessment begins with the facilitation and interaction between and among scientists and interested stakeholders within a given SES, the question of who exactly these individuals are immediately arises.[76] Similar to an EIS, a resilience assessment within the NEPA process requires an interdisciplinary team with scientific expertise relevant to the issues and setting involved.[77] Since a resilience assessment contemplates the co-production of knowledge,[78] it is also critical that the agency team include a trained facilitator. To identify appropriate community participation, there arises a need to explore social networks and examine social relations among individual actors or groups that either depend on natural resources or use their position to influence the governance process.[79] One approach is to map the extent of the stakeholder networks[80] and contact representatives and agents associated with key formal and informal institutions, with a message of a flexible, inclusive, diverse, and innovative collaboration among value-based stewards within the respective SES.[81] The key takeaway is that participants with knowledge and leadership within the community must be identified and invited in addition to any required public notice.

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[74] *Id.* at 9.
[75] *See* WAYFINDER, *supra* note 64.
[76] Enfors-Kautsky et al., *supra* note 68, at 7–8.
[77] *See, e.g.*, *Climate Change Guidance for National Environmental Policy Act Reviews*, EPA, https://www.epa.gov/nepa/climate-change-guidance-national-environmental-policy-act-reviews [https://perma.cc/49KP-LAVZ] (May 18, 2022).
[78] WALKER ET AL., *supra* note 59, at 47 tbl.4.
[79] *Id.* at 40.
[80] *See, e.g.*, David Knoke, *Policy Networks*, *in* THE SAGE HANDBOOK OF SOCIAL NETWORK ANALYSIS 210, 210–11 (John Scott & Peter J. Carrington eds., 2011).
[81] *See* Dietz et al., *supra* note 37, at 1907–09.

One question that arises in resilience assessment is resilience for whom? Minimizing inequity among the winners and losers of climate change begins with who participates in the initial resilience assessment. While collaborative processes and private collective action have been considered as promising means to govern in times of change and uncertainty in the adaptive governance literature,[82] concerns have been raised with the capacity of marginalized groups to participate, and the need to foster legitimacy, equity, and justice.[83] Lack of local capacity, particularly in rural areas, often requires that agency scientists reach out to local organizations and seek participation by representatives.[84] A public notice and even an invitation may be insufficient. Thus, at the stage of the initial assessment there is a role for the agency in building participatory capacity among those who might otherwise be marginalized.[85]

2. What Data, Information, and Local Knowledge Is Used?

The process of this collaboration works to define the SES's socioecological boundaries by collectively addressing the values, main challenges, drivers of change, potential thresholds, in addition to other biophysical, social, and economic components.[86] The outcome is intended to increase

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[82] *Id.*; Folke et al., *supra* note 43, at 441; Brian C. Chaffin, Hannah Gosnell & Barbara A. Cosens, *A Decade of Adaptive Governance Scholarship: Synthesis and Future Directions*, 19 ECOLOGY & SOC'Y, no. 3, 2014, at 1, 2, http://dx.doi.org/10.5751/ES-06824-190356 [https://perma.cc/C9LJ-NGWK].

[83] Cosens et al., *The Role of Law*, *supra* note 38, at 3–5; Cosens et al., *Governing Complexity*, *supra* note 14, at 1.

[84] *See* Cosens et al., *The Role of Law*, *supra* note 38, at 5.

[85] *Id.*

[86] WALKER ET AL., *supra* note 59, at 40. For example, for the resilience assessment of the catchment of Goulburn-Broken, Australia, the considerations included: the biophysical system, including climate change, surface hydrology, groundwater, vegetation, river channels, wetlands, and flood-plains; the biophysical subsystem, including agricultural system thresholds, dry land biodiversity thresholds, and aquatic and wetland biodiversity thresholds; the social system, including governance, social networks, institutions, and other human capital); the political system, including laws—property rights and legal norms; the economic system, including regional market, farm income and debt ratios, state of infrastructure, and other economic sectors; the values and main challenges, including threats to crop production, water storage decline, soil pH levels, native species decline, energy costs; and the drivers of change, such as slow variables (markets demands for products and services). Ryan H. Walker, Nick Abel, John M. Anderies & Paul Ryan, *Resilience, Adaptability, and Transformability in the Goulburn-Broken Catchment, Australia*, 14 ECOLOGY & SOC'Y, no. 1, 2009, at 1, 12, https://ecologyandsociety.org/vol14/iss1/art12/ [https://perma.cc/SYS3

knowledge and understanding of the system to influence decision-making in the face of accelerating change. It must also continually look to the future.[87] As stakeholders are tasked with identifying the factors that may build or erode resilience in the SES, a diversity of perspectives and methodologies is needed at the table—including not only formally trained experts in particular disciplines but also those with an informal yet insightful, rooted experience; those who have a lived understanding of the system to work together to identify the SES's position within the adaptive cycle.[88] As a useful exercise in a collaborative process, developing a timeline of past disturbances that have affected the SES and emphasizing key values and the factors that drove the system to its current phase within the adaptive cycle will feedback to the value-driven insights that can set and achieve the goals while accounting for thresholds and future disturbances.

While the call for multiple disciplines is similar to that of an EIS under NEPA, a resilience assessment requires attention to emergent properties of the system caused by the interaction of various components.[89] Thus, experts in interdisciplinary integration are needed. In addition, local knowledge may be on the front lines of identifying emergent response of the system to climate change. Developing approaches to encourage sharing of this information and how to validate it (particularly for purposes of judicial review) are critical to resilience assessment.

-22YN]; *see also* C.S. Holling, *Understanding the Complexity of Economic, Social and Ecological Systems*, 4 ECOSYSTEMS 390, 392 (2001).

[87] Cosens et al., *Governing Complexity*, *supra* note 14, at 1.

[88] *See* Reinette Biggs, Maja Schlüter, Duan Biggs, Erin L. Bohensky, Shauna BurnSilver, Georgina Cundill, Vasilis Dakos, Tim M. Daw, Louisa S. Evans, Karen Kotschy, Anne M. Leitch, Chanda Meek, Allyson Quinlan, Ciara Raudsepp-Hearne, Martin D. Robards, Michael L. Schoon, Lisen Schultz & Paul C. West, *Toward Principles for Enhancing the Resilience of Ecosystem Services*, 37 ANN. REV. ENV'T & RES. 421, 425 (2012) (explaining seven strategies to build resilience: (1) maintain response diversity and functional redundancy; (2) manage connectivity, by providing links to sources of ecosystem recovery or providing new information and building trust in social networks; (3) manage slow variables and feedbacks to maintain SES regimes that underlie the production of desired ecosystem services; (4) foster an understanding of complex adaptive systems, by emphasizing the need for more integrated approaches, the importance of continual learning, and the pervasiveness of uncertainty in the management of SES; (5) encourage learning about social-ecological dynamics and encourage experimentation through monitoring, which is essential for enabling adaptation in response to changes in SES and ecosystem services; (6) broaden participation, which is important for building trust and relationships because it facilitates the learning and collective action needed to respond to change and disturbance in SES; and (7) promote polycentric governance systems).

[89] WALKER ET AL., *supra* note 59, at 22, 25.

3. How Are the Goals Set?

By identifying the SES's position in the adaptive cycle and pinpointing the key indicators of how the focal system has and will develop dynamically over time, the stakeholders can then form goals to intervene at potential thresholds and manage disproportionate vulnerabilities.[90] Opportunities to design innovative strategies for change and then set goals to navigate toward the desired system state emerge.[91] The achievement of goals depends on the way in which key system components are managed—including the interaction, function, and response to rapid changes that are both internal and external to the system. At the same time, the management must respond to constraints imposed from larger-scale systems or to innovation from smaller nested scales.[92] Conceptual diagrams are most useful here for synthesizing the full extent of social-ecological

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[90] At the Columbia River Basin ("CRB") focal scale, first examine the data and information with regards to the SES components: physical resources and natural systems that provide food, energy, and water (water economy: hydropower, navigation, irrigation, fisheries, and anthropogenic alterations including irrigation, dams, agriculture, urban development, fish runs, wildlife, and forest); drivers of change: climate change (increasing average temperatures, snow-rain shift, flooding, drought, wildfire, pest and disease outbreak, and invasive species); land use and land cover change (population growth, growing demand for food, energy, and water); changing values; and slow variables: biodiversity loss, food web change, and soils. The Scale Below (the many sub-basins): biophysical system (water, rivers, groundwater, and reservoir created by dam, contains critical habitat for steelhead); forested, minerals, and precious metals. The Scale Above (national to global): historic timeline and drivers of change at larger scales (impacts at CRB and local scale); present day drivers (population growth, land use change, urbanization, climate change, hydrologic change, and wildfire); and potential political will or resource management shift to a "systems" approach (potential for precedent, Columbia River Treaty renegotiation with Canada). *See* Barbara Cosens & Alex Fremier, *Social-Ecological Resilience in the Columbia River Basin: The Role of Law and Governance*, *in* PRACTICAL PANARCHY FOR ADAPTIVE WATER GOVERNANCE: LINKING LAW TO SOCIAL-ECOLOGICAL RESILIENCE 47, 47–64 (Barbara Cosens & Lance Gunderson eds., 2018) ("[D]ams are a major factor in the decline of populations of salmon and steelhead species that are critical to the culture of Indigenous peoples."). *See also* Barbara Cosens, Lance Gunderson & Brian Chaffin, *The Adaptive Water Governance Project: Assessing Law, Resilience and Governance in Regional Socio-Ecological Water Systems Facing a Changing Climate*, 51 IDAHO L. REV. 1, 23–24 (2014).

[91] WAYFINDER, *supra* note 64.

[92] The goals can be set by collectively answering the specified resilience question of "resilience of what, to what?" *See* Carpenter et al., *supra* note 23, at 777, 779; *see also* Carl Folke, Johan Colding & Fikret Berkes, *Synthesis: Building Resilience and Adaptive Capacity in Social-Ecological Systems*, *in* NAVIGATING SOCIAL-ECOLOGICAL SYSTEMS: BUILDING RESILIENCE FOR COMPLEXITY AND CHANGE 352, 354 (Fikret Berkes, Johan Colding & Carl Folke eds., 2003).

interactions in the focal system, whereby goals for resilience management may be set among stakeholders and become involved in deliberation influencing decision-making.[93]

4. What Types of Scenarios Should Be Explored, and How Should Decision Makers Deal with Uncertainty?

Uncertainty around the timing and magnitude of threshold events presents complex challenges for proactive decision-making toward the goals desired among stakeholders for navigating toward adaptive or transformative change.[94] However, in the face of rapid change, proactive decision-making toward these goals is required to break entrenched patterns and to enable more sustainable development trends.[95]

First, uncertainty should be embraced in the initial assessments. Strategies for coping with uncertainty can be handled by probing the experts, and by demanding the use of the best available science and information available to sustain a reasoned goal and choice among alternative options. While information, data, and local knowledge offered as evidence cannot fully eliminate uncertainty, such science, modeling, and trusted information enables decision makers to assess the reliability, minimize uncertainty, and make sound judgments based on the best available information. That way, decision makers can act in the face of uncertainty, all while leaving flexible option spaces for the future to respond to changing circumstances. Tools for imagining multiple possible futures such as scenario planning are useful in this process.[96] Scenarios can capture both ends of the spectrum of uncertainty, as well as the

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[93] *See* Marieke Heemskerk, Karen Wilson & Mitchell Pavao-Zuckerman, *Conceptual Models as Tools for Communication Across Disciplines*, 7 ECOLOGY & SOC'Y, no. 3, 2003, at 1, 2, https://www.ecologyandsociety.org/vol7/iss3/art8/ [https://perma.cc/AFF4-73EW].

[94] WALKER ET AL., *supra* note 59, at 7.

[95] *See* Carpenter et al., *supra* note 23, at 777, 779 (exploring the operational indicators of resilience and then using those indicators, such as adaptive capacity, self-organization, and sustainability, in a discussion of the various uses of resilience). With regards to the process for designing innovative strategies for the desired adaptive or transformative change, resilience scholars Walker and Meyers have constructed a working database of published examples of regime shifts or thresholds. *See also* Brian Walker & Jacqueline A. Meyers, *Thresholds in Ecological and Social-Ecological Systems: A Developing Database*, 9 ECOLOGY & SOC'Y, no. 2, 2004, at 1, 13, https://www.ecologyandsociety.org/vol9/iss2/art3/ [https://perma.cc/K66F-AHE9] (explaining that this will enhance sustainability through intervention to shape thresholds and feedbacks in the socioecological system and even to provide ecological buffers that protects the system).

[96] *See* WALKER ET AL., *supra* note 59, at 47, 50.

system trajectories considered most likely by both experts and those with local knowledge.[97]

Second, the biggest difference between resilience assessment and traditional environmental assessment under NEPA is that the process of assessment itself must be ongoing and adaptive. In the initial assessment, points of departure around different scenarios may be identified. Monitoring as implementation occurs will help inform which trajectory the system is on. This information should feedback to allow revision of the project as well as adjustment of the initial assessment. In short, resilience assessment cannot be a one-time process but must follow any climate adaptation project through to completion and even to operation.

5. What Do the Outcomes Look Like and Are They Updated?

The resilience assessment process then moves to practical guidance for innovation from the SES scale or intervention from a higher scale to respond to the various forms of local climate impacts with a decision-making strategy.[98] The strategy is guided by a learning-by-doing approach to resource management, which enables management actions to follow the best available information to test the alternative scenarios and to continually learn from, refine, and improve an understanding of the system to better direct the goals and reduce the levels of uncertainty.[99] This iterative process of adaptive management works to enhance collaborative capacity, trust, relationships, and coordination among and between federal, state, and local agencies, tribes, and other public and private sector stakeholders, while maintaining a learning-while-doing approach as a key mode of operation.

III. CLIMATE ADAPTATION LAW: INTEGRATION OF RESILIENCE ASSESSMENT UNDER NEPA

NEPA already allows for interdisciplinary environmental assessments to be used across all governance institutions that influence environmental management and regulation, and it includes systematic monitoring and navigation of its programs and decision-making to promote SES resilience in the context of intergenerational climate

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[97] *Id.* at 13, 27.
[98] *See* WAYFINDER, *supra* note 64.
[99] *Id.*

justice.[100] NEPA provides a baseline regulatory framework for generating and releasing environmental impact information, and many states already have analogous statutes applicable to state and local agencies and are accustomed to the procedural framework for generating similar information for proposed agency actions and their impacts.[101] Numerous articles have explored the flexibility already present in NEPA.[102] This Part explores how resilience assessment might occur under NEPA. It begins by considering the compatibility between resilience assessment and NEPA. It then explores the degree of flexibility already contained within NEPA and whether that allows for full integration of resilience assessment into current environmental assessment. Concluding that there still remain necessary changes to NEPA's existing framework to recognize key differences among and between impact assessments and a resilience assessment to reconcile evolving solutions, this Part ends with a model amended NEPA.

A. Compatibility of Resilience Assessment with NEPA

The use of resilience assessment is readily applicable under three of NEPA's main actions and key requirements, namely: (1) the integrated effort and interdisciplinary approach; (2) the "hard look" analysis, and its early application; and (3) the alternatives analysis and enhanced public involvement.[103]

First, NEPA demands an integrated effort and an interdisciplinary approach, which includes directives from various sources, such as: executive orders; Council on Environmental Quality ("CEQ") regulations

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[100] Fischman, Meretsky, and Castelli's *Collaborative Governance Under the Endangered Species Act* is an example of research that examines how to achieve flexibility within existing environmental statutes (namely, the Endangered Species Act) to increase collaboration and climate adaptation law in the United States. Robert L. Fischman, Vicky J. Meretsky & Matthew P. Castelli, *Collaborative Governance Under the Endangered Species Act: An Empirical Analysis of Protective Regulations*, 38 YALE J. REG. 976, 991 (2021); *see also* Hannah Gosnell, Brian C. Chaffin, J.B. Ruhl, Craig Anthony (Tony) Arnold, Robin K. Craig, Melinda H. Benson & Alan Devenish, *Transforming (Perceived) Rigidity in Environmental Law Through Adaptive Governance: A Case of Endangered Species Act Implementation*, 22 ECOLOGY & SOC'Y, no. 4, 2017, at 1, 3, https://www.ecologyandsociety.org/vol22/iss4/art42/ [https://perma.cc/D8LF-BMVA].

[101] Julie Thrower, *Adaptive Management and NEPA: How a Nonequilibrium View of Ecosystem Mandates Flexible Regulation*, 33 ECOLOGY L.Q. 871, 879–80 (2006).

[102] For the most recent scholarship, see Glicksman & Page, *supra* note 13, at 122, 125.

[103] NEPA, 42 U.S.C. § 4332(2)(C).

and guidance; and agency policy and regulations—and it includes coordination among all federal agencies.[104] NEPA is often called an umbrella statute because it encourages agencies to incorporate all applicable environmental requirements into one analysis for a streamlined decision-making process.[105] It requires that all credible environmental disciplines (e.g., SES resilience science and practice) be included in the planning and decision-making process.[106] This is applicable both throughout assessment and the development of NEPA's document stage, including the Environmental Assessment ("EA") and EIS, in which an agency must: anticipate the preparation of project and program planning by establishing resources and a team, and scheduling into the future; develop an administrative record, its scoping process, its clear statements of purpose and need and proposed action; and must anticipate screening alternatives as a range of reasonable alternatives.[107] An integrated resilience assessment would encapsulate all of these features.

Second, NEPA requires the early application of a "hard look" impact analysis.[108] From the inquiry as to whether a proposed action will have significant socioecological effects, NEPA requires all federal agencies to look to the best available science when analyzing the direct, indirect, and cumulative impacts of the proposed action.[109] The significance criteria includes both *context*—including impacts on society as a whole, the particulars of the affected region, the locality, and short- and long-term effects—and *intensity*—including the severity of the impact, the degree of the impacts, the degree of the controversy, if it is cumulatively significant, and if it threatens violation of another environmental law or agency regulation.[110] Without the hard look of a systematic SES resilience assessment, any impact analysis would be deemed insufficient—as it would not fully account for the nonlinear dynamics, thresholds, and feedbacks

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[104] *Id.* §§ 4331, 4345.

[105] This broad applicability is evident in its language: "Include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed EIS statement by the responsible official . . . ." *Id.* § 4332(2)(C); *see also National Environmental Policy Act (NEPA)*, NAT'L INST. OF JUST., https://nij.ojp.gov/funding/national-environmental-policy-act-nepa [https://perma.cc/FA6B-XWGA] (last visited Jan. 16, 2023).

[106] *See* 42 U.S.C. § 4332(2)(A).

[107] *Id.*

[108] This leads to either the preparation of an EIS or the issuance of a Finding of No Significant Impact. *See id.* §§ 4331(a), 4344(2).

[109] *Id.* §§ 4331(c), 4344(2).

[110] *See generally* NEPA.

of the system and dismiss the initiation of a system of renewal and reorganization for the trajectory of a more stable and sustainable system.

Third, NEPA requires an alternative analysis and enhanced public involvement.[111] In the process of screening alternative feasibility, which includes a no-action alternative and an environmentally preferable alternative,[112] a resilience assessment would readily account for this in its options space—which would detail strategies for adaptive and transformative change and strategies to avoid locking systems into trajectories that restrict and reduce future choices. As NEPA requires transparent disclosure of information presented concisely to the public,[113] the resilience assessment would fill this need through its approach to production of knowledge. Resilience assessments are also applicable in all interim actions: programmatic analysis; tiering; supplementing analysis; multiple records of decision ("RODs"); and changes to RODs—as a resilience assessment would inform and guide the direction of each consideration involved in the NEPA analysis. The NEPA resilience assessment could then determine the system trajectory, developed by those that reflect the values and concerns of the communities and extend across generations, and direct flexible management to improve the structural and functional capacities of a SES.

B. Achieving Full Integration: Embracing Key Differences, Handling New Solutions, and Making Meaningful Amendments

To achieve full integration of resilience assessment under NEPA, three main inquires arise: (1) in what way does an EIS differ from a resilience assessment; (2) is the flexibility already found within NEPA sufficient to allow for resilience assessment; and, if not, (3) how would NEPA need to be amended to allow for resilience assessment in the context of climate adaptation?

First, key differences between an EIS and a resilience assessment include:

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[111] 28 C.F.R. § 91.51(a)(4) (2004). "Use the NEPA process to identify and assess reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment." *Id.*

[112] *See* 43 C.F.R. § 46.30 (2008). The CEQ explains that: "[EISs] shall be concise, clear, and to the point, and shall be supported by evidence that the agency has made the necessary environmental analyses." 40 C.F.R. § 1502.1 (2020).

[113] *See* 42 U.S.C. § 4332.

- Who is included in the room. On the one hand, in an EIS, the agency experts are the ones in the room, and they then inform the public during scoping and once a draft EIS is completed. On the other hand, with a resilience assessment, all interested stakeholders are encouraged and co-production of the assessment is contemplated.
- The goal. Unlike an EIS which is intended to evaluate the environmental impacts of multiple alternatives to a chosen option, generally already expressed in legislation or management mandates, a resilience assessment would be done in the context of climate change in which the action that will result in impacts is inevitable and it is the choice among various scenarios for adaptation and transformation that must take place. In addition, a resilience assessment is itself part of the process of building SES adaptive capacity.
- Predictability of system response. Whereas an EIS is systematically conditioned to focus its assessment within a predictable range of system response to a proposed action and its alternatives, the possibility of nonlinear dynamics, cascading change, and the potential of approaching and crossing thresholds associated with climate change involves a high degree of uncertainty and rate of change. If anything, assuming predictability is a dangerous choice in the face of climate change. A resilience assessment handles uncertainty by making decisions that increase a system's resilience to disturbance and its protection of those most vulnerable to change.
- Contemplation of the need for ongoing monitoring and adjustment. The need for ongoing monitoring and adjustment is an integral part of the resilience assessment process. In certain situations, the need for adaptive management is identified within the EIS process. The work of scholars and agencies to develop means to integrate adaptive management into environmental assessment in certain circumstances and the adequacy of this approach for climate adaptation are discussed below.

- Timing of meaningful judicial review. Judicial review under NEPA is based on the final EIS document, which is a one-time review. As noted below in the discussion of flexibility in NEPA, a supplemental EIS and subsequent opportunity for review may take place in the context of adaptive management. For resilience assessments, due to the high degree of initial uncertainty, review must be based on progress toward achieving its goals.[114] This enables a break in the gridlock of judicial review and the learning-while-doing structure necessary to confront the complex and uncertain impacts of accelerating change.[115] The focus is on whether the posed implementation measure has a reasonable relation to the goal, guided by principles of intergenerational climate justice, and whether the implementation is achieving outcomes that are trending toward the specified goal, including whether there is any violation of individual rights.[116]

Second, recognizing the need for flexibility in situations of scientific uncertainty, agencies and scholars have sought means to implement adaptive management within the existing NEPA process of environmental assessment with some success.[117] In an excellent overview of existing agency approaches, Robert Glicksman describes the various ways land management agencies have handled the question of how to do adaptive management while complying with NEPA.[118] The approaches recommended and adopted by various land management agencies range from stating that a new NEPA analysis may occur when an adjustment is

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[114] Michael C. Dorf & Charles F. Sabel, *A Constitution of Democratic Experimentalism*, 98 COLUM. L. REV. 267, 267–68 (1998); Eric Biber & Josh Eagle, *When Does Legal Flexibility Work in Environmental Law?*, 42 ECOLOGY L.Q. 787, 799–800 (2016).

[115] Dorf & Sabel, *supra* note 114, at 287. This governance arrangement also requires "information pooling," which is an essential aspect of inserting stability back into the flexible government design to allow for experimentations for preferable solutions. This information pooling will increase the efficiency of public administration, heighten accountability, and enhance the ability of agencies to assist the regulated entities and actors all while monitoring their performance.

[116] *See id.* at 288, 398–400.

[117] *See* sources cited *supra* note 13; *see, e.g.*, THE NEPA TASK FORCE, *Chapter 4: Adaptive Management and Monitoring*, *in* MODERNIZING NEPA IMPLEMENTATION 44, 46–47 (2003).

[118] Glicksman & Page, *supra* note 13, at 138–52.

made,[119] to identifying the adjustments that can be made in the initial EIS,[120] to use of adaptive management in the context of mitigating measures to avoid an EIS altogether.[121]

Glicksman also reviews the litigation resulting from efforts to adopt adaptive management in the context of NEPA.[122] While plaintiffs have argued that each adjustment under an adaptive management plan is a major federal action triggering NEPA, courts have held that supplemental review is necessary when the adjustment is a substantial change[123]—a requirement already embedded in CEQ regulations.[124]

It is unlikely that these avenues for flexibility are adequate in the context of climate mitigation and resilience assessment. In a rapidly changing system, upfront identification of mitigation measures or of potential adjustments is unlikely.[125] Development of a supplemental assessment each time an adjustment to adaptation measures is made could undermine the adaptive capacity of the SES. Nevertheless, a process which allows for ongoing adjustment is ripe for corruption,[126] thus ongoing public involvement and access to judicial review is an essential aspect of resilience assessment. Given the high level of uncertainty, however, it is important that review be focused on substantive progress toward goals,[127] not procedural adjustments.

Finally, amending NEPA would not only allow for the differences between an EIS and resilience assessment to be reconciled but also inform how judicial review should take place. Amending the law will allow for the differences to be reconciled by stipulating that federal agencies must prepare a resilience assessment that discloses the effects of, and alternatives to, action impacts related to resilience and capacity building as an

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[119] *Id.* at 141.
[120] *Id.* at 147–51.
[121] *Id.* at 136.
[122] *Id.* at 152.
[123] *Id.* at 157; *see also* Robin Kundis Craig & J.B. Ruhl, *Designing Administrative Law for Adaptive Management*, 67 VAND. L. REV. 1, 33 (2014) (presenting model legislation for addition of an adaptive management tract to the Administrative Procedures Act; while not proposed in the NEPA context, the authors contemplate public involvement and judicial review following each review and decision to make adjustments).
[124] *See* Glicksman & Page, *supra* note 13, at 179–80.
[125] *See also* Camacho, *supra* note 13, at 14, 71 (noting in the context of adaptive governance rather than resilience assessment, but similarly in the context of climate change, "NEPA would have to be fundamentally re-fashioned for it to serve as a comprehensive adaptive governance framework").
[126] Biber & Eagle, *supra* note 114, at 793, 828.
[127] Dorf & Sabel, *supra* note 114, at 434; *see also* Biber & Eagle, *supra* note 114, at 803.

alternative to the EIS.[128] The procedural framework for generating information for proposed agency activities can then use this information to adjust the goals for policy implementation.[129] The regulatory context of an EIS would ensure the implementation of resilience assessments as a more formalized process of interagency cooperation.[130] The legislative directives must also include sufficient resources and incentives for regulators and stakeholders and continually encourage learning while doing.[131]

C. Amending NEPA: A Model

The following paragraphs shows amendments within the current text of the National Environmental Policy Act of 1969 as amended.[132] Additions are shown as underlined. Deletions are shown with strikethrough.

The National Environmental Policy Act of 1969, as Amended and with Proposed Amendments[133]

An Act to establish a national policy for the environment, to provide for the establishment of a Council on Environmental Quality, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Environmental Policy Act of 1969."

Purpose

Sec. 2 [42 USC § 4321]. The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between ~~man~~ humans and ~~his~~ their environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of ~~man~~ humans and the resilience of social-ecological systems; to enrich the understanding of the

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[128] Thrower, *supra* note 101, at 878, 894.
[129] Shalanda H. Baker, *Adaptive Law in the Anthropocene*, 90 CHI.-KENT L. REV. 563, 580 (2015) (explaining that this is a process known as triple-loop-learning).
[130] *See* Gosnell et al., *supra* note 100, at 4–5.
[131] *See id.* Top-down regulations and government programs could enhance further stakeholder innovation and provide incentives for enhanced collaboration to prevent further top-down regulation.
[132] *See generally* NEPA.
[133] *See generally id.*

ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

It is the purpose of the 2022 amendment to this Act to provide for resilience assessment instead of an environmental impact assessment or statement for certain Federal actions including, but not limited to, climate adaptation, in which change is occurring in the social-ecological system involved and as a consequence there is high uncertainty in the impacts of the proposed action. The substitution of resilience assessment is intended to recognize that in rapidly changing systems, return to historic conditions or maintenance of the current system state may no longer be options, and yet the quality of the human environment for present and future generations remain the national policy under this Act as well as the current and future resilience of the human environment in the face of change. It is also intended to recognize that in the face of change and uncertainty, a one-time pre-project assessment of environmental impacts is no longer adequate to ensure the quality and resilience of the human environment.

TITLE I

CONGRESSIONAL DECLARATION OF NATIONAL ENVIRONMENTAL POLICY

Sec. 101 [42 USC § 4331].

(a) The Congress, recognizing the profound impact of ~~man's~~ human's activity on the interrelations of all components of the natural environment, particularly the profound influences of climate change, population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality and managing resilience ~~to~~ in the overall welfare and development of ~~man~~ humanity, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which ~~man~~ humans and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consist with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may—

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
3. attain the widest range of beneficial uses of the environment without degradation of social-ecological resilience, risk to health or safety, or other undesirable and unintended consequences;
4. preserve important historic, cultural, and natural aspects of our national heritage, and ~~maintain~~ promote, wherever possible, an environment which supports resilience, diversity, and variety of individual choice;
5. achieve a balance between population and resource use which will permit high standards of living and a wide and equitable sharing of life's amenities (including intergenerational sharing); and
6. enhance the quality and resilience of renewable resources and approach the maximum attainable recycling of depletable resources.

(c) The Congress recognizes that each person and future generations should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation, ~~and~~ enhancement, and resilience of the environment.

Sec. 102 [42 USC § 4332]. The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act including Section 2 and 101, and (2) all agencies of the Federal Government shall—

(A) utilize a systematic, interdisciplinary approach which will ~~insure~~ ensure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on ~~man's~~ the human environment;

(B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by title II of this Act, which will ~~insure~~ ensure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations;

(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the current and future human environment according to the criteria in section (C)(3) either,

1. a detailed statement by the responsible official on—

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of ~~man's~~ human's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented; or

2. a detailed resilience assessment by the responsible official and developed with the communities affected by—

(i) the impact of the proposed action on the present and future resilience of the social-ecological system affected;

(ii) the possible system trajectories;

(iii) the degree of scientific uncertainty involved in determining possible system trajectories;

(iv) any use of local knowledge in the assessment;

(v) the degree of participation by the communities potentially affected including marginalized populations within the communities; and

(vi) a timeframe for periodic review of data collected on the results of implementation with subsequent consideration of adjustments to the proposed action.

Resilience assessment shall include requirements for data collection on the results of implementation of the proposed action for purposes of adjustment to the proposed action and measuring progress toward goals.

3. The Council on Environmental Quality shall develop guidelines to determine when a resilience assessment rather than an environmental impact statement is appropriate. In any project to address climate adaptation it shall be presumed that a resilience assessment is the appropriate track. To overcome that presumption and for all other Federal actions, the guidelines shall require analysis that considers, but is not limited to—

(i) the degree of scientific uncertainty in the consequences of the proposed action;

(ii) the degree and rate of change the social-ecological system involved is undergoing regardless of whether that change is related to the proposed project;

(iii) whether the affected social-ecological system is close to or has crossed a threshold rendering restoration to prior conditions unlikely or unwarranted;

(iv) the degree to which the livelihoods of people in the affected communities are dependent on the resources the proposed action is related to; and

(v) the degree to which the proposed action will alter the livelihoods of those in the affected communities.

Prior to making any detailed statement or resilience assessment, the responsible Federal official shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved and the criteria in the guidelines developed under section (C)(3) to determine if a detailed statement or resilience assessment is necessary. Copies of such statement or assessment and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public as provided by section 552 of title 5, United States Code, and shall accompany the proposal through the existing agency review processes;

(D) Any detailed statement or resilience assessment required under subparagraph (C) after January 1, 1970, for any major Federal action funded under a program of grants to States shall not be deemed to be legally insufficient solely by reason of having been prepared by a State agency or official, if:

(i) the State agency or official has statewide jurisdiction and has the responsibility for such action,
(ii) the responsible Federal official furnishes guidance and participates in such preparation,
(iii) the responsible Federal official independently evaluates such statement prior to its approval and adoption, and
(iv) after January 1, 1976, the responsible Federal official provides early notification to, and solicits the views of, any other State or any Federal land management entity of any action or any alternative thereto which may have significant impacts upon such State or affected Federal land management entity

and, if there is any disagreement on such impacts, prepares a written assessment of such impacts and views for incorporation into such detailed statement.

The procedures in this subparagraph shall not relieve the Federal official of ~~his~~ their responsibilities for the scope, objectivity, and content of the entire statement or assessment or of any other responsibility under this Act; and further, this subparagraph does not affect the legal sufficiency of statements prepared by State agencies with less than statewide jurisdiction.

(E) study, develop, and describe appropriate alternatives and scenarios to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;

(F) recognize the worldwide, ~~and~~ long-range, and intergenerational character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality and resilience of mankind's world environment;

(G) make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality and resilience of the environment;

(H) initiate and utilize ecological information in the planning and development of resource-oriented projects; and

(I) assist the Council on Environmental Quality established by title II of this Act.

Sec. 103 [42 USC § 4333]. All agencies of the Federal Government shall review their present statutory authority, administrative regulations, and current policies and procedures for the purpose of determining whether there are any deficiencies or inconsistencies therein which prohibit full compliance with the purposes and provisions of this Act and shall propose to the President not later than July 1, 1971, such measures as may

be necessary to bring their authority and policies into conformity with the intent, purposes, and procedures set forth in this Act.

Sec. 104 [42 USC § 4334]. Nothing in section 102 [42 USC § 4332] or 103 [42 USC § 4333] shall in any way affect the specific statutory obligations of any Federal agency (1) to comply with criteria or standards of environmental quality, (2) to coordinate or consult with any other Federal or State agency, or (3) to act, or refrain from acting contingent upon the recommendations or certification of any other Federal or State agency.

Sec. 105 [42 USC § 4335]. The policies and goals set forth in this Act are supplementary to those set forth in existing authorizations of Federal agencies.

TITLE II

COUNCIL ON ENVIRONMENTAL QUALITY

Sec. 201 [42 USC § 4341]. The President shall transmit to the Congress annually beginning July 1, 1970, an Environmental Quality Report (hereinafter referred to as the "report") which shall set forth (1) the status and condition of the major natural, manmade, or altered environmental classes of the Nation, including, but not limited to, the air, the aquatic, including marine, estuarine, and fresh water, and the terrestrial environment, including, but not limited to, the forest, dryland, wetland, range, urban, suburban and rural environment; (2) current and foreseeable trends in the quality, management and utilization of such environments and the effects of those trends on the social, economic, and other requirements of the Nation; (3) the adequacy of available natural resources for fulfilling human and economic requirements of the Nation in the light of expected population pressures; (4) a review of the programs and activities (including regulatory activities) of the Federal Government, the State and local governments, and nongovernmental entities or individuals with particular reference to their effect on the environment and on the conservation, development and utilization of natural resources; ~~and~~ (5) a program for remedying the deficiencies of existing programs and activities, together with recommendations for legislation; and (6) a review of all activities of Federal, State, Tribal, and local governments related to climate mitigation and adaptation measures including the need for capacity building resources.

Sec. 202 [42 USC § 4342]. There is created in the Executive Office of the President a Council on Environmental Quality (hereinafter referred to as the "Council"). The Council shall be composed of three members who shall be appointed by the President to serve at his pleasure, by and with the advice and consent of the Senate. The President shall designate one of the members of the Council to serve as Chairman. Each member shall be a person who, as a result of his training, experience, and attainments, is exceptionally well qualified to analyze and interpret environmental trends and information of all kinds; to appraise programs and activities of the Federal Government in the light of the policy set forth in title I of this Act; to be conscious of and responsive to the scientific, economic, social, aesthetic, and cultural needs and interests of the Nation; and to formulate and recommend national policies to promote the improvement of the quality and resilience of the environment.

Sec. 203 [42 USC § 4343].

(a) The Council may employ such officers and employees as may be necessary to carry out its functions under this Act. In addition, the Council may employ and fix the compensation of such experts and consultants as may be necessary for the carrying out of its functions under this Act, in accordance with section 3109 of title 5, United States Code (but without regard to the last sentence thereof).

(b) Notwithstanding section 1342 of Title 31, the Council may accept and employ voluntary and uncompensated services in furtherance of the purposes of the Council.

Sec. 204 [42 USC § 4344]. It shall be the duty and function of the Council—

1. to assist and advise the President in the preparation of the Environmental Quality Report required by section 201 [42 USC § 4341] of this title;
2. to gather timely and authoritative information concerning the conditions and trends in the quality of the environment both current and prospective, to analyze and interpret such information for the purpose of determining whether such conditions and trends are interfering, or are likely to interfere, with the achievement of the policy set forth in title I of

this Act, and to compile and submit to the President studies relating to such conditions and trends;

3. to review and appraise the various programs and activities of the Federal Government in the light of the policy set forth in title I of this Act for the purpose of determining the extent to which such programs and activities are contributing to the achievement of such policy, and to make recommendations to the President with respect thereto;
4. to develop and recommend to the President national policies to foster and promote the improvement of environmental quality and resilience to meet the conservation, social, economic, health, and other requirements and goals of the Nation for both current and future generations;
5. to conduct investigations, studies, surveys, research, and analyses relating to ecological systems, ~~and~~ environmental quality, and social-ecological resilience;
6. to document and define changes in the natural environment, including the plant and animal systems, and to accumulate necessary data and other information for a continuing analysis of these changes or trends, ~~and~~ an interpretation of their underlying causes, and the adaptive capacity of the social-ecological system reliant on these systems;
7. to report at least once each year to the President on the state and condition of the environment; and
8. to make and furnish such studies, reports thereon, and recommendations with respect to matters of policy and legislation as the President may request.

Sec. 205 [42 USC § 4345]. In exercising its powers, functions, and duties under this Act, the Council shall—

1. consult with the Citizens' Advisory Committee on Environmental Quality established by Executive Order No. 11472, dated May 29, 1969, and with such representatives of science, industry, agriculture, labor, conservation organizations, State and local governments and other groups, as it deems advisable; and

2. utilize, to the fullest extent possible, the services, facilities and information (including statistical information) of public and private agencies and organizations, and individuals, in order that duplication of effort and expense may be avoided, thus assuring that the Council's activities will not unnecessarily overlap or conflict with similar activities authorized by law and performed by established agencies.

Sec. 206 [42 USC § 4346]. Members of the Council shall serve full time and the Chairman of the Council shall be compensated at the rate provided for Level II of the Executive Schedule Pay Rates [5 USC § 5313]. The other members of the Council shall be compensated at the rate provided for Level IV of the Executive Schedule Pay Rates [5 USC § 5315].

Sec. 207 [42 USC § 4346a]. The Council may accept reimbursements from any private nonprofit organization or from any department, agency, or instrumentality of the Federal Government, any State, or local government, for the reasonable travel expenses incurred by an officer or employee of the Council in connection with his attendance at any conference, seminar, or similar meeting conducted for the benefit of the Council.

Sec. 208 [42 USC § 4346b]. The Council may make expenditures in support of its international activities, including expenditures for: (1) international travel; (2) activities in implementation of international agreements; and (3) the support of international exchange programs in the United States and in foreign countries.

Sec. 209 [42 USC § 4347]. There are authorized to be appropriated to carry out the provisions of this chapter not to exceed $300,000 for fiscal year 1970, $700,000 for fiscal year 1971, and $1,000,000 for each fiscal year thereafter.

Sec. 210 (New Section). Judicial Review: Resilience assessment anticipates that high uncertainty will require continuing adjustment of the agency action to achieve the stated goals of the proposed action. Thus, a final agency action within the meaning of Administrative Procedure Act section 704 is not possible.

Judicial Review in the context of a Resilience Assessment may be sought as follows—

Any person may seek judicial review of implementation of the proposed action if progress is not made toward the goal and in the timeframes provided in the resilience assessment.

Prior to seeking review, notice must be provided to the lead agency and a 90-day period for negotiated adjustment of implementation measures pursued. Extension of the 90-day period may occur on agreement between the person filing and the action agency.