Untapped capacity for resilience in environmental law

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Over the past several decades, environmental governance has made substantial progress in addressing environmental change, but emerging environmental problems require new innovations in law, policy, and governance. While expansive legal reform is unlikely to occur soon, there is untapped potential in existing laws to address environmental change, both by leveraging adaptive and transformative capacities within the law itself to enhance social-ecological resilience and by using those laws to allow social-ecological systems to adapt and transform. Legal and policy research to date has largely overlooked this potential, even though it offers a more expedient approach to addressing environmental change than waiting for full-scale environmental law reform. We highlight examples from the United States and the European Union of untapped capacity in existing laws for fostering resilience in social-ecological systems. We show that governments and other governance agents can make substantial advances in addressing environmental change in the short term—without major legal reform—by exploiting those untapped capacities, and we offer principles and strategies to guide such initiatives.

resilience | law | social-ecological systems | environmental governance

Environmental governance has made significant progress in addressing many of the challenges facing humankind, but it has not stemmed the tide of accelerating environmental change, nationally or internationally. This fact is perhaps most obvious in the limited international agreements to address climate change as both greenhouse gas emissions and atmospheric concentrations of carbon dioxide continue to increase, and biodiversity loss, nutrient pollution, and ocean acidification also signal increasing needs for reform (1). As a result, subsidiary governments (e.g., US states, provinces, regions, cities) and other governance actors [e.g., private industry, nongovernmental organizations (NGOs)] have become critical innovators (2). Nevertheless, rapidly accelerating environmental change demands further attention to national and international environmental law, particularly the need to identify and leverage the untapped capacity to enhance resilience that already exists in these laws.

Adaptive and transformative capacities are inherent characteristics of social-ecological systems that collectively influence the resilience of these systems. We use "resilience" in the sense of ecological resilience (3)—the ability of a social-ecological system to absorb change without shifting to a new regime with a different set of processes and structures. Adaptive capacity describes the potential a social-ecological system has to alter resilience in response to change and maintain the current social-ecological regime; a system with high adaptive capacity is more likely to remain resilient given substantial episodes of change (4). Transformative capacity describes the potential of a social-ecological system to shift to a different, but still productive and socially desirable, regime that is again resilient to disturbance (5). Systems with low adaptive or transformative capacity, like the Newfoundland cod fishing communities of the 1980s and 1990s, collapse in the face of change (6). Not all social-ecological systems fully leverage their adaptive and transformative capacities, nor do they need to at all times. However, in an era of intense, novel, and disruptive environmental change, no latent capacity to adapt to change or to transform productively should remain unexplored.

Environmental law, and its ability to influence environmental governance more generally, provides 1 source of such latent capacity. Environmental governance is composed of law, policy, governance organizations, and individuals. "Law" refers to formal prescriptions, duties, prohibitions, rights, and requirements—constitutions, statutes, regulations, court decisions, rules, charters—that governmental bodies create (7). "Policy," in turn, describes less formal goals, aspirations, and intentions (8). Finally, "governance organizations" are all of the entities that implement various kinds of law and policy from formal governmental entities (government officials, agencies, courts) to NGOs such as trade associations, corporate boards, or neighborhood associations (9).

Emerging research indicates that a key source of adaptive and transformative capacity in governance is likely to be informal, realized through networks, social processes, and cultural knowledge (5). However, researchers so far have generally overlooked the potential for more formal environmental governance components as sources of adaptive and transformative capacity, despite the fact that the United States (US) and nations of the European Union (EU) repeatedly experience some of this capacity when new US presidents or European national leaders redirect existing laws to further new government policy agendas.

Significance

International and national law have not stemmed the tide of rapidly accelerating environmental change. In response to this challenge, we highlight examples from the United States and the European Union of the untapped capacity of existing laws to enhance social-ecological resilience to these continual changes. The recommendations we advance regarding how to mine existing legal instruments to enhance resilience are agenda-setting, and they represent a far more feasible approach to addressing emerging environmental challenges than proposing politically untenable new laws or major amendments to existing laws. We show that governance can make substantial advances in addressing environmental change in the short term by exploiting those existing untapped capacities, and we offer principles and strategies to guide such initiatives.

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Ideally, governments would engage in environmental law reform to integrate new scientific understanding and new social-ecological realities. However, because the rapid, broad-scale reform of existing environmental law necessary to respond to emerging environmental crises is unlikely, and furthermore may be unpredictable and undesirable in outcome, identifying adaptive and transformative capacity in existing laws may buy time in the short term to allow for the longer-term development of a more comprehensive governance regime for the future (10).

Law is generally hierarchically structured; legal instruments higher in the hierarchy are generally superior in effect, more general in level of detail, and more difficult to change. In the United States, for example, the Constitution generally sets up broad governmental capacities and constrains governmental powers, taking precedence over any conflicting law lower in the hierarchy. The Constitution has been amended only 15 times in the past 200 y. Congress and the president enact statutes to implement the federal government's constitutional authorities. Although new statutes are frequently enacted and existing statutes are frequently amended, the process can be slow and contentious, as it has been particularly for environmental law in the United States (9). Many statutes, such as most environmental law statutes, set general standards and procedures and rely on administrative agencies to implement the details through promulgating regulations that have the force of law (11). Courts play a role by interpreting the Constitution, statutes, and agency regulations, and presidents play a role by steering administrative agencies under their control in directions consistent with political goals. A similar hierarchy of laws and systems of political influence operate in the European Union.

The kind of legal reform necessary to respond comprehensively and forcefully to new and accelerating environmental crises would likely require substantial revision at constitutional and statutory levels to chart new overarching goals and authorities. There is little evidence that the United States, the European Union, or other nations are prepared and willing at this time to initiate that scale of reform. But a substantial degree of legal reform can take place, rapidly by comparison to change at constitutional and statutory scales, via agencies and courts through their adaptive implementation and interpretation of statutes (11–13). For example, a statutory mandate that an agency "protect water quality" is open to wide interpretation and an array of mechanisms for implementation. Indeed, with statutory environmental law essentially unchanged in the United States for several decades, a tremendous amount of legal reform has taken place through agency action and judicial processes (9). This is the kind of dynamic process that we argue can be leveraged even more aggressively in the United States, European Union, and in similar legal regimes—while still operating within the bounds of existing higher-authority laws (constitutions, treaties, statutes)—to make progress on responding to mounting environmental challenges.

Here, we describe the first-generation and current focus of environmental law, focusing on why change is needed. We then identify examples of untapped capacities in existing higher-authority laws in the United States and European Union for enhancing resilience, and we offer principles and strategies to guide such initiatives.

The Mismatch between Existing Environmental Law and Social-Ecological Systems

Governments intended their first-generation environmental laws, the initial wave of which emerged in the United States and the European Union in the 1970s, to improve, preserve, and maintain ecosystems in current or historic regimes and designed these laws around what has been called "front-end" assessment and decision-making processes (7). Given prevailing scientific norms at the time, legislatures based these laws on the assumption that ecosystems have an inherent balance—a single-equilibrium state—that ecosystem managers could predictably restore through manipulation and mitigation of system inputs and components (14, 15). Most simply, US pollution control statutes like the Clean Water Act presume that removing anthropogenic pollution will induce aquatic (and other) systems to return to desired conditions (15). A bit more complexly, using the kind of administrative reform capacity described above, US federal agencies implementing the Clean Water Act and Endangered Species Act established impact mitigation programs built on the premise that developers could compensate for destroying resources in 1 location by restoring or enhancing similar resources in another location, with no overall net impact to ecosystems as a whole (16). In the European Union a similar approach exists, requiring development mitigation in the same designated protected area to protect similar habitats (17). In most such programs, the government entity in charge makes the mitigation decision at the time it issues development permits on the assumption that ecosystems will respond in predictable ways that the government can evaluate at the "front end" of decision making (7).

We now know that this assumption is wrong; there is no inherent equilibrium state, and altered systems like eutrophicated lakes do not spontaneously return to "normal" when nutrient pollution stops (15). Nevertheless, laws in the United States and European Union have not evolved to integrate this knowledge, and because they continue to assume ecosystem stability and predictability, they are not well suited for coping with either scale mismatches between governance and ecosystems or the dynamic complexity of social-ecological systems (18). In addition, laws imposing elaborate predecisional processes, such as the US Endangered Species Act and Administrative Procedure Act and the EU Natura 2000, constrain government agency adoption of resilience-promoting approaches such as adaptive management (7, 19). Laws requiring agencies to base management decisions on predecisional comprehensive environmental assessments, such as the US National Environmental Policy Act, can impede the flexibility needed for adaptive decision-making (7).

Notably, environmental law researchers and practitioners have begun to question the premises of equilibrium and predictability, and some regulatory programs have moved past those principles (15). In addition, some more recent legal regimes, such as the 1980 US Toxic Release Inventory and the 1990 US Clean Air Act sulfur dioxide trading program, have shifted to more dynamic approaches using information reporting and markets (19). Even so, by and large the old statutes designed around the "front-end" approach continue to dominate environmental law, particularly in land and resources development contexts (7). Moreover, comprehensive and deep legal reform is unlikely any time soon in either the United States or the European Union.

We can, however, identify and leverage untapped elements of existing laws and develop new policies that have potential to enhance resilience in social-ecological systems. For example, the EU 2000 Water Framework Directive is a newer law that incorporates adaptive water management based on a river basin approach. As such, it already shifts law from the traditional approach of regulating pollution discharges toward ensuring integrated ecosystem protection and inclusive, equitable, and fair water supply for all. Even so, the Directive was not well suited to address new challenges in water management, such as water scarcity, impeding its ability to enhance the resilience of communities. Nevertheless, by using provisions (i.e., adaptive and transformative capacities) already existing within the Directive, river basin managers have begun to evolve their management plans to explicitly address the effects of environmental change, such as droughts and periods of water scarcity, improving communities' abilities to respond to change (20). Similarly, the European Union identified adaptive and transformative capacities in the agriculture subsidy component of its Common Agricultural Policy so that it could use the Policy to serve multiple goals,

not only to promote agriculture, but also to include protection of ecosystems and ecosystem services (21).

These examples suggest that a more concerted effort should be devoted to leveraging untapped adaptive and transformative capacity in existing environmental law. The question is how to do so in a manner guided by resilience principles responding to accelerating environmental change.

Adapting Environmental Governance

Many aspects of environmental governance help to shape adaptive and transformative capacity, including budgets, leadership, and politics (5, 7). We focus here on the untapped adaptive and transformative capacity that exists within law (as defined above) and the law's ability to shape environmental governance more generally. As noted above, the acceleration of familiar and new environmental disruptions demands legal reform, but new national and international legislation is unlikely. However, governance organizations and actors can prime the pump through creative interpretations and applications of existing laws, provided there is political will to shift policies in a new direction.

Three aspects of existing law are important in this regard. First, existing law can have untapped adaptive and transformative capacity to change itself—that is, capacity to create new requirements, standards, and prohibitions in order to adapt to changing social-ecological conditions or to pursue goals that reflect a transformed social-ecological system (22). For example, existing flexibility in the US Magnuson–Stevens Fishery Conservation and Management Act can allow regional Fishery Management Councils both to adjust catch allowances as ocean water warms and to require fishers to shift their permits to new species as marine fisheries migrate poleward (23). In both cases, managers use existing statutory provisions to change the law itself in ways that both exploit the statute's resilience to changing fish stocks and strengthen the fishing community's resilience to environmental change. Of course, such flexibility has limits: The Magnuson–Stevens Act is almost useless if the fishing community needs to transform into a completely different economic and cultural identity.

Second, existing law can have the capacity to open up legal space within a social-ecological system to allow that system to more effectively exercise its own adaptive and transformative capacities. For example, if law has forced managers to keep a protected area in an increasingly artificial regime [e.g., the landscape around a protected area maintained as grassland has already transformed to a woodland (24)], existing law might be able to remove those managerial constraints, freeing the protected ecosystem's transformative capacity to respond to the changing climate.

Finally, adaptive capacities and transformative capacities within existing laws are likely to derive from the same legal provisions. As a result, there will often be considerable overlap between sources of legal adaptive capacity and legal transformative capacity because both will often depend on substantive flexibility and procedural discretion.

A concerted effort to tap into environmental law's adaptive and transformative capacities will involve 3 overarching initiatives. First, where possible under existing higher-authority laws, adaptive and transformative law mechanisms should be leveraged. Second, these legal mechanisms must be operationalized pursuant to guidelines cognizant of social-ecological realities. Third, innovations in governance organizations should be embraced when they offer potential to facilitate the first 2 initiatives.

Leveraging Adaptive and Transformative Law Mechanisms. Both legal systems as a whole and particular legal regimes (e.g., species protection) vary in their capacities to promote innovative approaches to environmental problems, with factors such as cyclic planning, assessing monitoring results, enforcement mechanisms, flexibility in law, the rate of statutory change, and litigation all playing roles in legal adaptive and transformative capacity (25). Both in the United States and the European Union, these legal capacities draw from both the substantive flexibility (i.e., the goals and standards of laws) and procedural discretion (i.e., process of rulemaking and adjudication) that is built into laws (26).

Substantive legal adaptive and transformative capacity reflect the ability of a legal regime to alter its requirements, standards, and goals—large and small—in response to changed conditions. For example, federal land management agencies in the United States operate under a variety of statutorily mandated management regimes, from preservation mandates (e.g., many national monuments) to mixed conservation-commodity goals, such as the National Park Service's and the US Fish and Wildlife Service's dominant-use mandates (conservation) or the US Forest Service's and Bureau of Land Management's multiple-use mandates (manage for multiple uses as specified in the applicable statutes). Agencies operating under single- or limited-focus mandates lag behind others in terms of substantive adaptive capacity because, in particular, preservation mandates limit management options. The dominant-use and multiple-use agencies thus have found it easier to integrate adaptive management and other approaches, such as provisioning of ecosystem services, into their decision making (26, 27).

Procedural legal adaptive capacity refers to a legal regime's agility to promulgate, amend, evolve, enact, and/or implement law in light of new substantive goals and standards articulated in adapted substantive laws (28). In general, the more process required and the more checkpoints or decision makers involved, the less procedural adaptive capacity a particular area of law has (7). Thus, the common law, relying initially on the judgment of single judges, with doctrines crafted and refined over time by successive judicial opinions, is more procedurally adaptive than the legislative process (28). Nevertheless, as the European Union Water Framework Directive approach demonstrates, a legislative process can also be adaptive.

A multitude of options available under existing environmental and natural resources laws can promote adaptive and transformative capacity when deployed wisely. First, several tools already exist that increase the law's own adaptive and transformative capacity. Laws can allow or require the use of standards that automatically adjust to changing ecological conditions, promoting flexibility in environmental governance. For example, in interstate water allocation in the American West, proportional allocation of a river based on the actual yearly flow allows the affected states to adapt more easily both to drought and to longer-term changes in climate than would fixed requirements to deliver a certain amount of water at a certain place downstream (28, 29). Legislatures can also creatively employ "sunset" provisions to increase the adaptive and transformative capacity of laws. While legal sunsets often simply terminate a statute or regulation on a certain date unless the legislature or agency re-enacts that provision, legislatures and agencies can also use sunset provisions to require a more detailed review of a law at a certain point in the future. The European Union Water Framework Directive, for example, schedules review and public input every 3 to 5 y, allowing agencies to implement adaptive approaches without subverting public participation (7). Even more comprehensive review in conjunction with a termination of the existing version of a law could allow the legislature or agency to completely overhaul a sunsetted statute or regulation either to reflect transformed conditions or to guide a transformation in progress toward a productive altered system.

Second, as noted, governance entities can use existing law to create conditions that allow social-ecological systems to exercise their own adaptive and transformative capacities. For example, instead of mandating that protected areas remain in defined regimes (24), the law enabling certain protected areas can instead preserve and strengthen inherent adaptive and transformative capacities latent in social-ecological systems (27) so that they can adapt or productively transform in response to changing

conditions. In a different approach, governments and other entities can use financial incentives and public recognition (e.g., tax relief for protecting critical wildlife corridors; subsidies for ecosystem services in agricultural areas) to shape private behavior in ways that increase the adaptive and transformative capacity of the relevant social-ecological systems without requiring significant legal change (30). For example, Poland is using rural development incentives to create and preserve wetlands, an approach that taps adaptive capacity in the existing incentive program to improve flood management (31), increasing communities' resilience to both flood disasters and climate change in the process. In the United States, cities have leveraged legal incentives to use green infrastructure to address urban stormwater pollution via pervasive and transformative "naturalization" of urban landscapes, enhancing their resilience to environmental change (e.g., increasing frequency and intensity of precipitation) (5).

These and similar adaptations and transformations rely on creative thinking about the capacity and limits of existing laws. Agencies can interpret open-ended terms in statutes to provide authority for introducing new approaches and goals (11, 12). For example, a mandate to protect environmental resources for "public benefit" provides an open portal for incorporating ecosystem services concepts, stream flow preservation, public health concerns, and myriad other considerations into decision-making (13, 27). Although there are constitutional and other limits on such innovation (11, 32, 33), examples of successful innovations are growing in the United States and the European Union.

Operationalization Guidelines. Our call for more experimentation in leveraging existing laws demands new guiding principles to replace the front-end, all-is-predictable approach. "Principled flexibility" is 1 approach to guiding the deployment of adaptive and transformative capacities (34). This approach recognizes that resilience of social-ecological systems requires that some environmental requirements, such as controls on pollution, be strengthened even as governance entities pursue other kinds of flexibility (34). In other words, "adaptation" and "transformation" should not cloak an environmental governance free-for-all.

Two additional overarching policy principles that must serve as guides include the recognition of scale and of system interactions. Scale is a focus in the life and social sciences, but it has received less attention from lawmakers, policymakers, and natural resource managers. For example, watershed management in the United States can be subject to city or county land-use planning, state laws and policies, state–federal or state–federal–tribal water arrangements, and federal law (34), which is similar to the multilevel and multisector approach in the European Union and among its member states. The coordination of these disparate laws (and stakeholders) to generate appropriate, effective, and scale-specific governance interventions has proven challenging. Lack of coordination has particularly impeded progress in resolving large-scale environmental issues, such as nutrient pollution throughout the Mississippi River watershed causing hypoxia in the northern Gulf of Mexico (35) or water pollution from the Wisla (Vistula) River contributing to nutrient loading in the Baltic Sea (36). Existing laws often contain untapped capacities to meet these cross-scale challenges. For example, with respect to the Mississippi River, a US National Academy of Sciences committee concluded that, even though legal reforms would help, existing provisions of the Clean Water Act were sufficient to institute significant improvements in the watershed's management (35).

As important, but even less developed, is the need to identify and quantify cross-scale interactions, which are critical to managing resilience (37). The history of environmental law and policy globally is littered with examples of adverse management outcomes that resulted from a lack of attention to cross-scale interactions. For example, laws and policies that encourage land conversion to agriculture and cities at local scales have resulted in biodiversity loss at global scales (38). Successful leveraging of latent legal adaptive and transformative capacities must be cognizant of these cross-scale effects.

Innovative Governance Arrangements. The need for creative legal interpretations to implement policies aimed at managing multiscale interactions will demand new organizational configurations that join governance entities across scales and public and private divides. Even if limited to existing organizations, new hybrid arrangements can deliver on multiscale policy goals (39).

For example, hybrid mechanisms of law, policy, and informal governance may be able to better protect systemic resources (e.g., coral reefs) but will require government enforcement mechanisms to produce desirable environmental outcomes (18). Hybrid governance arrangements have arisen over time, with significant authority to implement management interventions (28). Bridging organizations (e.g., NGOs that provide leadership and coordination) and cultivating networks (e.g., collaborators, partnerships) are both significant aspects of resilience-based governance (40). Importantly, bridging organizations are often already in place in a system and, in some cases, can simply be repurposed to resolve scale mismatches, improve communication, share information, and coordinate with stakeholders (29). For example, in The Netherlands, strict conservation laws and a lack of cross-scale coordination undermined restoration of the Markermeer (Lake Marken). A nature conservation organization's active involvement led to new investments and new infrastructure projects to restore the lake. The organization's leadership and networking created social acceptance, allowing lake restoration to proceed in ways that met nature conservation standards (41).

More formally, 2 of the most pervasive adaptive and transformative capacities in US environmental law, especially pollution control laws, are cooperative federalism and the explicit preservation (as opposed to preemption) of state law. Under cooperative federalism, federal laws explicitly create areas of state (and now tribal) regulatory prerogative (e.g., water quality standards under the Clean Water Act, implementation plans under the Clean Air Act, nonhazardous waste regulation under the Resource Conservation and Recovery Act), reflecting Congress's recognition that tribes and states (and their municipalities) often can better tailor general environmental goals (e.g., fishable and swimmable waters under the Clean Water Act) to local social-ecological realities (32, 42). At the same time, these federal statutes leave most state law in place to deal with issues that the statutes do not, such as tort liability for pollution (32). Building on this well-established tradition, the US government has begun to reemphasize the subsidiarity principle, delegating additional aspects of environmental protection to smaller-scale governments and using hybrid governance approaches when appropriate (28). Such approaches may allow better matching between the scale of perturbation faced and the governance response; they also allow and even encourage more local innovation to adapt or transform in response to changing local conditions.

Increased attention to subsidiarity in US environmental policy might also take advantage of adaptive and transformative capacities at multiple scales by simultaneously tapping federal, state, and local capacities and engaging informal components of governance. For example, US Supreme Court decisions have left unclear the status of many wetlands under federal law (43). In response, many states now use state law to protect wetlands that federal law may not (44), while land trusts and environmental NGOs such as the Nature Conservancy create private protections for wetlands under state property law, state conservation easement laws, and local zoning. Thus, by exploiting the multiple adaptive and transformative capacities created through cooperative federalism and savings provisions in federal law, states and environmental NGOs have increased the resilience of wetland-dependent

social-ecological systems to various kinds of change, compared to what federal law alone would have accomplished.

In the same spirit, the EU Adaptation Strategy connects adaptation goals to a diversity of other policy fields, such as ecosystem management, disaster risk reduction, and the Common Agricultural Policy. Through this integrated approach, the European Union seeks to identify and use untapped adaptive and transformative capacities to better address environmental challenges. The strategy is focused on providing opportunities and facilitating decision-making at the local and regional level (45), in line with the elevated consideration that the European Union gives to the issue of subsidiarity and the respective roles of public and private actors.

There are efforts underway to better understand the elements of environmental governance—law, policy, governance organizations, and individuals—that are truly transformative by studying transformative capacity and governance in social-ecological systems (5). Significant, targeted investment and innovation in either the law or its implementation at timely intervention points can also serve as a catalyst for transforming social-ecological systems from degraded to more desirable conditions (5). For example, laws that set and require monitoring of social-ecological thresholds, such as the US Clean Water Act and Safe Drinking Water Act that protect drinking water supplies, can help to identify possible intervention points and thus opportunities to innovate, such as by using green infrastructure to simultaneously improve urban water quality and adapt to worsening "heat island" impacts (46).

Conclusion

Leveraging untapped capacity for enhancing social-ecological resilience in existing environmental law has not received adequate attention. This is important, because attempts to govern social-ecological systems to date have not resulted in effective—i.e., desirable and productive—adaptation to rapidly accelerating environmental change. At the same time, transformation will become increasingly necessary, and, in many cases, social-ecological systems cannot be restored to prior conditions (15). Thus, crafting environmental governance systems to manage the effects of environmental change across multiple ecological scales and administrative levels has been problematic. A persistent challenge for environmental governance originates from the complexity generated by scale-specific and cross-scale interactions, the occurrence of discrete but difficult to predict thresholds, and the dearth of methods to objectively assess relative resilience (47). For environmental governance to be effective, the organization of social-ecological systems across time and space needs to be accounted for in law and policy. Over time, science has developed tools useful for determining the scaling structure in ecosystems (47). An essential first step, therefore, is to communicate to policymakers the biophysical components (e.g., biodiversity, landscape structure) that influence the resilience of social-ecological systems to changing realities and how the distribution of these components within and across scales of ecosystems matters for environmental governance.

However, that is only a first step; better deployment of existing resources is also critical. We have highlighted aspects of existing environmental law that are problematic for governance of rapid environmental change. More research and action are needed, but as an interim path forward, we have highlighted some examples of the untapped potential of adaptive and transformative capacities in existing environmental laws that could enhance resilience in social-ecological systems. These existing capacities provide managers and other governance entities with tools immediately available to address the complexity and nonstationarity of social-ecological systems in a changing world.

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