Becoming Landsick: Rethinking Sustainability in an Age of Continuous, Visible, and Irreversible Change

by Robin Kundis Craig

Robin Kundis Craig is the
William H. Leary Professor of Law at the
University of Utah S.J. Quinney College of Law.

Summary

This Article is adapted from Chapter Four of *Rethinking Sustainability to Meet the Climate Change Challenge*, edited by Jessica Owley and Keith Hirokawa and published by ELI Press. The author argues that climate change adaptation is absolutely necessary because we have passed the point of avoiding climate change impacts. Because adaptation is fundamentally about coping with continual change, we must abandon mainstream notions of sustainability, which assume a relatively stationary world. We instead should adopt three transforming principles: (1) pursue resilience rather than maintenance of particular socioecological states; (2) recognize and emphasize that private interests must yield to community survival; and (3) stop avoiding the subject of human population growth. These principles will help us acquire "climate change sea legs" and face the challenges to come.

Most people know what it means to be seasick: When a land-dwelling human being goes out on the ocean—or out on a lake big enough to entertain significant water movement—the swell, waves, and constant motion induce nausea and vomiting. Seasickness is one form of the more general ailment known as motion sickness, a physiological reaction to the brain's confusion when the nervous system's three pathways for sensing motion—"the inner ear (sensing motion, acceleration, and gravity), the eyes (vision), and the deeper tissues of the body surface (proprioceptors)"—produce uncoordinated signals about what the body is doing.[1] In brief—and to highlight the metaphorical import of seasickness for this Article—human beings tend not to react well to unintentional motion and change.

However, human beings are also adaptable. Stay out at sea long enough, and you develop "sea legs"—that is, an ability to cope with the constant change and motion that goes with being on a ship at sail. Moreover, human beings will often carry their sea legs back on shore with them, causing landsickness. Landsickness is the inverse of traditional motion sickness, where a human body that has become used to constant motion suddenly goes back to stable land.[2] Most people readjust fairly quickly to being back on land, but in some people, landsickness persists as a more-or-less permanent condition, an affliction known as Mal de Debarquement syndrome. Researchers believe that in patients suffering from this syndrome, "the brain may be stuck believing that the rocking motion experienced at sea is normal and that being on land is disorienting."[3]

In this climate change era, we all need to rewire ourselves into a metaphorical Mal de Debarquement syndrome—that is, into a state where we view constant change as the norm, not as an aberration to be ignored, avoided, or resisted. As a more positive formulation, we need to acquire our climate change sea legs—and, as will be shown below, that means jettisoning mainstream notions of sustainability. Such popular conceptions of sustainability assume a relatively stationary world, impeding humans' ability to deal with the realities of climate *change*.

Author's Note: My thanks to the organizers of the Environmental Law Collaborative for including me in the original discussions regarding the future of sustainability.

1. Sy Kraft, *What Is Motion Sickness (Travel Sickness)? What Causes Motion Sickness?*, Med. News Today, Jan. 15, 2010, http://www.medicalnewstoday.com/articles/176198.php; *see also* Charles W. Bryant, *What Is Landsickness?*, Discovery Fit & Health (last visited July 9, 2013), http://health.howstuffworks.com/mental-health/neurological-conditions/landsickness.htm.
2. Bryant, *supra* note 1.
3. *Id.*; *see also* Elizabeth Svoboda, *Even on Land, Seasickness Doesn't Always Go Away*, N.Y. Times, June 12, 2007.

I. Adapting to Climate Change

We have entered the era of climate change adaptation, which is most fundamentally about coping with continual, and often unpredictable, change. Adaptation is absolutely necessary because we have passed, definitively, the point of avoiding climate change impacts.

While there are many greenhouse gases, carbon dioxide is the one of greatest general climatic concern, both because of its ubiquity and because it is the greenhouse gas most significantly attributable to anthropogenic sources. In May 2013, global average concentrations of carbon dioxide in the atmosphere exceeded 400 parts per million for the first time in three to five million years—that is, since before modern humans inhabited Earth.[4] These concentrations do not bode well for the planet's many systems, including the socioecological systems upon which humans depend.[5]

Carbon dioxide does eventually cycle out of the atmosphere, but the process is slow. Carbon dioxide persists in the atmosphere for "'a few centuries, plus 25 percent . . . lasts essentially forever,'"[6] and "[t]he warming from our CO_2 emissions would last effectively forever, too."[7] As a result, even if all greenhouse gas emissions ended tomorrow (which will not be the case), humans will be stuck with change-inducing carbon dioxide levels in the atmosphere for a while—almost certainly at least a couple of centuries, and probably much longer,[8] especially if global efforts to mitigate climate change by reducing greenhouse gas emissions remain half-hearted.[9]

The fact that Earth's climatic and ecological conditions are changing in ways that directly and indirectly affect human well-being is also now well-accepted. For example, in its December 2012 second edition of *Climate Change Indicators in the United States*, the U.S. Environmental Protection Agency (EPA) emphasized that "[t]he Earth's climate is changing."[10] More specifically, the climate change indicators that the Agency uses to objectively measure changes in the United States' climate

> present compelling evidence that the composition of the atmosphere and many fundamental measures of climate in the United States are changing. Temperatures are rising, snow and rainfall patterns are shifting, and more extreme climate events—like heavy rainstorms and record high temperatures—are taking place. Similar changes are occurring around the world.[11]

As some specific examples, "[f]rom 1990 to 2011, the total radiative forcing from greenhouse gases added by humans to the Earth's atmosphere increased by 30 percent," with carbon dioxide accounting for about 80% of the increase.[12] "Radiative forcing" is a measure of how greenhouse gases affect energy absorption in the atmosphere, and "[a]n increase in radiative forcing means a heating effect, which leads to warming. . . ."[13] To confirm this impact, global and United States average temperatures have been increasing, leading to reductions in precipitation in some places, heavy precipitation events in others, and drought.[14] Ocean average temperatures and sea surface temperatures have also been increasing, and global average sea level is rising at an accelerating rate of more than one inch per decade.[15] Arctic sea ice is melting, winter snowfall is decreasing, and snowpack has been decreasing throughout the United States—in some places by more than 75%.[16] Streamflow patterns are changing across the United States, and the growing season has lengthened in most places by about two weeks compared to a century ago, accompanied by an increase in the length of the ragweed pollen season.[17]

Among the most compelling of EPA's descriptions are the impacts that climate change is already having on human health. Over the last 30 years, more than 7,000 Americans have died directly as a result of heat-related illnesses such as heat stroke, and that number increases significantly when heat is considered a contributing factor to deaths.[18] More generally, EPA notes, "[a] warmer climate will increase the risk of heat-related illness and death" but should also "decrease the risk of cold-related illness and death."[19] Climate change will also: (1) worsen air pollution, especially ground-level ozone, in many parts of the country, aggravating lung diseases and leading to increased numbers of premature deaths; (2) increase the frequency and severity of extreme weather events such as storms and floods, putting human lives and health at risk; (3) shift the range of certain diseases (such as mosquito-borne diseases)

4. Brian Vastag & Jason Samenow, *Carbon Dioxide Concentrations Hit Troubling Milestone, Scientists Say*, Wash. Post, May 10, 2013.
5. For example, "The temperature during that period, known as the Pliocene Epoch, was 5 to 7 degrees warmer than today, with seas tens of feet higher." *Id*.
6. Mason Inman, *Carbon Is Forever*, Nature Reports Climate Change, Nov. 20, 2008 (quoting oceanographer David Archer).
7. *Id*.; *see also* Cornelia Dean, *Emissions Cut Won't Bring Quick Relief, Scientists Say*, N.Y. Times, Jan. 27, 2009, at A21 (noting that "the effects of carbon dioxide persist").
8. Intergovernmental Panel on Climate Change, Climate Change 2007: Impacts, Adaptation, and Vulnerability 14, 20 (2007) [hereinafter 2007 IPCC Adaptation Report] (noting that "additional adaptation measures will be required to reduce the adverse impacts of projected climate change and variability, regardless of the scale of mitigation undertaken over the next two to three decades" and that "[e]ven the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential, particularly in addressing near-term impacts."); *see also* U.S. Environmental Protection Agency, Climate Change Indicators in the United States 3 (2d ed. 2012) [hereinafter 2012 EPA Climate Indicators Report] (noting that "[c]urrent and future emissions will continue to increase the levels of these gases in our atmosphere for the foreseeable future."); U.S. Global Change Research Program, Draft Third National Climate Assessment 5 (2013), *available at* http://ncadac.globalchange.gov/ [hereinafter 2013 Draft USGCRP National Assessment] ("As a result of past emissions of heat-trapping gases, some amount of additional climate change and related impacts is now unavoidable.").
9. *See* Robin Kundis Craig & Melinda Harm Benson, *Replacing Sustainability*, 46 Akron L. Rev. 841, 841-43 (2013) (discussing the disappointing recent failure of the climate negotiations).
10. 2012 EPA Climate Indicators Report, *supra* note 8, at 3.
11. *Id*.
12. *Id*. at 6.
13. *Id*.
14. *Id*. at 7.
15. *Id*. at 8.
16. *Id*. at 8-9.
17. *Id*. at 9.
18. *Id*.
19. *Id*. at 74.

and alter the seasons for pollen, increasing disease exposure, asthma, and other respiratory diseases; and (4) put already at-risk populations such as the poor and elderly at greater risk.[20]

The U.S. Global Change Research Program (USGCRP), in its January 2013 draft *Third National Climate Assessment*, similarly emphasized the current and future import of rising temperatures for socioecological systems. According to the USGCRP, the average temperature in the United States has increased by 1.5°F since 1895, with 80% of the increase occurring since 1980.[21] Over the next few decades, U.S. average temperatures will increase another 2°F to 4°F,[22] and by the end of the century, average temperatures could increase by as much as 10°F.[23] Changes in the climate and ecological impacts resulting from these increasing temperatures "have affected and will continue to affect human health, water supply, agriculture, transportation, energy, and many other aspects of society. . . ."[24] As a result, "[c]limate change produces a variety of stresses on society, affecting human health, natural ecosystems, built environments, and existing social, institutional, and legal agreements."[25]

II. Climate Change Adaptation and Governance

As the USGCRP suggests, coping with these continuing changes has become a recognized governance issue. EPA, for example, noted in late 2012 that the observed changes in climate systems "can also affect society, including where people can live, what kinds of crops people can grow, and what kinds of businesses can thrive in certain areas."[26] Indeed, any or all of the projected changes and disruptions could warrant new or expanded governance measures, from emergency aid to assisted relocation to revitalized and refocused farming extension programs. In addition, EPA recognized, "[c]limate-related health indicators will be instrumental not only in tracking and measuring the health impacts of climate change but also, more importantly, in identifying areas where the protection of public health is needed most."[27]

Many scientists, legal scholars, and governance institutions have acknowledged that adaptation to climate change is now necessary and unavoidable. As early as 2007, the Intergovernmental Panel on Climate Change (IPCC) noted that "[a]daptation is necessary in the short and longer term to address impacts resulting from the warming that would occur even for the lowest stabilisation scenarios assessed."[28] In 2008, representatives of the World Bank declared that adaptation must become a co-strategy with mitigation efforts for dealing with climate change, because "[r]isks associated with climate change could greatly increase vulnerability unless adaptation is stepped up."[29] In March 2013, the Obama Administration released its *National Fish, Wildlife, and Plants Climate Adaptation Strategy*, which announces that "[a]daptation actions are vital to sustaining the nation's ecosystems and natural resources—as well as the human uses and values that the natural world provides."[30] The European Commission adopted its more general *EU Strategy on Adaptation to Climate Change* in April 2013,[31] acknowledging that

> [w]hatever the warming scenarios, and however successful mitigation efforts prove to be, the impact of climate change will increase in the coming decades because of the delayed impacts of past and current greenhouse gas emissions. We therefore have no choice but to take adaptation measures to deal with the unavoidable climate impacts and their economic, environmental and social costs.[32]

So, climate change adaptation is the new reality, and climate change adaptation is, by definition, about coping with change. Specifically, adaptation is an acknowledgement that climate change is already changing most of the important components of those processes: the temperature of the atmosphere, of regions of the oceans, of land, and of various freshwater bodies; atmospheric and oceanic currents; the chemical composition of the atmosphere; the chemical composition of regions of the oceans; the relative humidity in various regions; precipitation patterns throughout the world; the habitability of particular ecosystems by particular species; natural checks on pest species through temperature and other seasonal changes; and the productivity of various landscapes.[33]

Indeed, the USGCRP posited adaptation as a governance challenge for coping with often unpredictable and sometimes extreme change.[34] More generally, as others

20. *Id.*
21. 2013 Draft USGCRP National Assessment, *supra* note 8, at 3.
22. *Id.*
23. *Id.*
24. *Id.* at 4.
25. *Id.* at 5.
26. 2012 EPA Climate Change Indicators Report, *supra* note 8, at 3.
27. *Id.* at 74.
28. Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report: Summary for Policymakers 19 (2007) [hereinafter 2007 IPCC Summary for Policymakers].
29. Rasmus Heltberg et al., *Addressing Human Vulnerability to Climate Change: Toward a "No Regrets" Approach*, 19 Global Envtl. Change 89, 98 (2009); *see also id.* at 89 ("Adaptation—adjusting to address ongoing and future climate changes—is increasingly recognized as an urgent and necessary complement to greenhouse gas emissions reductions.") (internal citation omitted); Thomas Lovejoy, *Mitigation and Adaptation for Ecosystem Protection*, 39 ELR 10072, 10073 (Jan. 2009) ("The adaptation part of the climate change agenda is only just beginning to get attention, and needs much more right away.").
30. National Fish, Wildlife, and Plants Climate Adaptation Partnership, National Fish, Wildlife, and Plants Climate Adaptation Strategy iii (2012).
31. Communication From the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions: An EU Strategy on Adaptation to Climate Change COM 216 (Apr. 16, 2013).
32. *Id.* at 2.
33. *See* Robin Kundis Craig, *"Stationarity Is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 Harv. Envtl. L. Rev. 9, 9-15 (2010) (discussing these changes).
34. 2013 Draft USGCRP National Assessment, *supra* note 8, at 984 ("Planning and managing based on the climate of the last century means that tolerances of some infrastructure and species will be exceeded. . . . For example, building

have put it, "stationarity is dead."[35] Our future is a moving and always shifting target, and we are now, like it or not, sailing the climate change sea.

III. Rethinking Sustainability

It is against this new reality of constant change and threatened disruption that we have to measure the continuing value of "sustainability"—as a concept, as a goal, and as a principle to guide governance and law. Notably, the United States has clung to the mantra of "sustainability" (whatever the word might mean in particular contexts) while simultaneously exhibiting what might be termed "climate change seasickness"—a refusal to adapt to the new reality of change, as evidenced by the denials and refusals to act that have characterized much of the American response to climate change until recently. Even assuming that we get past that seasickness, however, does the concept and goal of sustainability help us to adapt to climate change?

The answer is, quite simply, "No."[36] While sustainability must accept a certain amount of (contained) variability, it is at heart about ensuring persistence—that is, about sustaining *something* (development, carbon fuel-based lifestyles, the American standard of living, specific ecosystems) indefinitely and hence about denying deep and transforming socioecological change. As a result, sustainability, at least as pursued in the United States, promotes the myth of stationarity[37] and, as Michael Burger has suggested, the utopian belief that we can have it all.[38]

Of course, even independently of a climate change perspective, scholars have criticized sustainability as a governance principle, arguing that, even if implemented as intended, sustainability still falls short as a paradigm to guide humans' interaction with the environment. In 1998, for example, Peter Marcuse pointed out that socially unjust programs can be just as sustainable as socially just ones[39]: there is nothing inherently normative or good, in other words, about the capacity to endure. Marcuse thus cautioned that "even in the environmental arena, sustainability cannot be the sole criterion by which programmes are judged except in the, not useful, very long term because environmental policies must also take into account considerations of, for example, social justice. . . ."[40]

More recently, Annie Rochette argued that sustainability and especially sustainable development are not enough of a paradigm shift from prior views of humanity's relationship to nature. Employing an ecofeminist framework, Rochette argued that

> sustainable development, as it is presently conceptualized, is so fundamentally flawed that it will not likely be achieved, even if the international community focuses all its efforts on the implementation of *Agenda 21*. The main flaw of sustainable development lies in its failure to challenge the fundamental assumptions of the dominant development model that it seeks to replace, as well as its dependence on the global market economy. Furthermore, the concept of sustainable development does not sufficiently address the marginalization of the poor and especially women in developing countries, where women continue to be disproportionately affected by environmental degradation, yet are largely excluded from the process of sustainable development.
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> . . . . Finally, we argue that sustainable development is based on the androcentric view of humans as separate and above Nature, a view that has led to the overexploitation of Nature. Unless this core concept of sustainable development is challenged, a sustainable future for the planet is impossible.[41]

In her critique, sustainable development depends on "permanent economic growth,"[42] raising the significant concern "that sustainable development has come to signify 'sustained economic growth,' thus jeopardizing environmental protection."[43] As a result, "sustainable development thus fails to question the assumption that continuous economic growth will eventually lead to the destruction of the planet."[44]

Climate change raises less of a social critique to sustainability as a policy goal; instead, it exposes sustainability's roots in stationarity and hence the inherent conflict between climate change adaptation and sustainability.[45] As noted, sustainability is by definition the ability to sustain *something*: the verb needs an object, and the goal of sustainability needs a particular focus or foci—an eco-

codes and landscaping ordinances will likely need to be updated not only for energy efficiency, but also to conserve water supplies, protect against disease vectors, reduce susceptibility to heat stress, and improve protection against extreme events. . . .").

35. P.C.D. Milly et al., *Stationarity Is Dead: Whither Water Management?*, 319 Sci. 573, 573 (2008); Craig, *supra* note 33, at 9-13.
36. *See generally* Melinda Harm Benson & Robin Kundis Craig, *The End of Sustainability*, 2014 Society & Natural Resources 1-6 (May 7, 2014), DOI:10.1080/08941920.2014.901467, *available at* http://dx.doi.org/10.1080/08941920.2014.901467; Craig & Benson, *supra* note 9, at 845-62.
37. *See* D. Stralberg et al., *Re-Shuffling of Species With Climate Disruption: A No-Analog Future for California Birds?*, 4:9 PLoS ONE e6825, doi:10.1371/journal.pone.0006825 (2009); D. Fox, *Back to the No-Analog Future?*, 316 Sci. 824, 824 (2007); T. Dietz, Elinor Ostrom & P.C. Stern, *The Struggle to Govern the Commons*, 302 Sci. 1907, 1907 (2003).
38. Michael Burger, *Sustainable Utopias and the Climate Change Apocalypse*, *in* Rethinking Sustainability to Meet the Climate Change Challenge (ELI Press 2015).
39. Peter Marcuse, *Sustainability Is Not Enough*, 10:2 Envt. & Urbanization 103, 103 (1998).
40. *Id.* at 104.
41. Annie Rochette, *Stop the Rape of the World: An Ecofeminist Critique of Sustainable Development*, 51 U. New Brunswick L.J. 145, 149-50 (2002). Nations of the world adopted Agenda 21, to which Rochette refers, at the 1992 United Nations Conference on Environment and Development, also known as the Rio Conference. Agenda 21 presents a set of comprehensive principles and objectives for simultaneously achieving and balancing social improvement, economic development, and environmental protection, a combination generally known as "sustainable development." *See generally* U.N. Conference on Environment and Development, *Agenda 21*, U.N. Doc. A/CONF.151/6/Rev. 1 (1992), *reprinted in* 31 I.L.M. 881 (1992), *available at* http://sustainabledevelopment.un.org/content/documents/Agenda21.pdf.
42. Rochette, *supra* note 41, at 161.
43. *Id.* at 162.
44. *Id.*
45. *See* Craig & Benson, *supra* note 9, at 846-49; Benson & Craig, *supra* note 36, at 3-4.

system, a socioecological system, extant biological diversity, economic growth, development, human health—but something.[46] To talk about sustainability in the abstract is to philosophize, not to pursue meaningful governance policies and laws. Moreover, as Marcuse assumed, sustainability invokes a capacity to endure and persist, leading to goals that seek to perpetuate, unaltered, certain aspects of socioeconomic systems indefinitely—continuous economic growth, according to Rochette; continuous dependence on fossil fuels, to many (as attested, inter alia, by almost immediate calls on government to do something every time gasoline prices in the United States rise); continuously improving standards of living for an ever-growing human population, in much of the rest of the world.

When discussing sustainability in the climate change era, two other points are also critical. First, we've *never* been very good at sustainability, even when anthropogenic impacts on the world were far less obvious and pervasive than they are now. Adopting the Bruntland Commission Report and Agenda 21 as starting points, the pursuit of sustainability and sustainable development has occurred in an emerging climate change era.[47] In 1990, the IPCC issued its *First Assessment Report*, which concluded that human activities were responsible for substantially increasing the atmospheric concentrations of the greenhouse gases.[48] Two years later, the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, cognizant of the IPCC's report, reflected a shared sense of urgency regarding the need to change how we think about development, explicitly adopting sustainable development as a goal.[49]

Thus, the adoption of the sustainability principle in global governance has always been linked to, if not impelled by, emerging cognizance of anthropogenic global climate change. Nevertheless, since 1992, both human consumption of resources and emissions of greenhouse gases have only increased, with no signs of stopping.[50] As a result, in anticipation of the "Rio+20" Conference held in 2012, the U.N. Environment Programme concluded that "if current patterns of production and consumption of natural resources prevail and cannot be reversed and 'decoupled,' then governments will preside over unprecedented levels of damage and degradation."[51] It reported the increasingly likely possibility of large-scale irreversible change, concluding that critical global, regional, and local thresholds are quickly being approached or, in some cases, have already been crossed.[52] A growing number of scientists around the world have expressed similar concerns, calling for increased attention to "tipping points" that could cause sudden, irreversible changes in relatively stable-appearing (and humanly beneficial) ecological conditions.[53]

Tipping points and threshold crossings lead to the second point regarding sustainability in the climate change era: When the only constant in life is continual socioecological change, including threshold crossings into entirely new states of being and catastrophic collapses, sustainability is a meaningless concept as a practical matter. You can't sustain an ecosystem if the fundamental features of that ecosystem are constantly changing, and especially not if the ecosystem flips into a new state of being. You can't sustain a socioecological system if its foundations are radically different from what they were 20 years ago and will be radically different again 20 years from now. You can't sustain a particular economy if the bases of that economy are disappearing. You can't sustain a culture's integrity if its members are rapidly becoming climate change refugees, or if the traditional ecological components of that culture have transformed into something else. All you can do is adapt.

IV. Acquiring Climate Change Sea Legs

Climate change thus requires that we replace goals of sustainability with something else, at least for any policy goal more concrete and specific than leaving a functional planet to the next generations. Acquisition of our climate change sea legs, this Article concludes, would be aided considerably if we adopted three transforming principles for cultural norms, governance goals, and laws and legal institutions.

1. Pursue Resilience, Not the Maintenance of Particular Socioecological States.[54] In 2009, the U.S. Climate Change Science Program concluded that "it is essential to increase the resilience of ecosystems . . . and to employ adaptive management strategies to deal with new conditions, new successional trajectories and new combinations of species."[55] Resilience thinking offers a new model for coping with climate change, because it accepts ecological change and threshold crossings as baseline realities, avoiding the trap of the stationarity-based assumptions that characterize sustainability.[56]

46. *See* Craig & Benson, *supra* note 9, at 847.
47. *See* U.N. World Commission on Environment and Development, *Our Common Future*, U.N. Doc. A/42/427, Annex (1987), *available at* http://www.un-documents.net/our-common-future.pdf, and *Agenda 21*, *supra* note 41.
48. *See generally* J.T. Houghton, The 1990 Report of the IPCC Scientific Assessment Working Group (1990) (reporting that climate change was occurring and that human emissions contributed to it); K. Hasselmann, *Are We Seeing Global Warming?*, 276 Sci. 914, 914-15 (1997).
49. Rochette, *supra* note 41, at 145-46.
50. Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report 2 (2007) [hereinafter 2007 IPCC Synthesis Report]; W.V. Reid et al., Millennium Ecosystem Assessment Synthesis Report 17 (2005); N. Myers, *Consumption: Challenge to Sustainable Development*, 276 Sci. 53, 53-54 (1997).
51. Press Release, United Nations Environment Programme, World Remains on Unsustainable Track Despite Hundreds of Internationally Agreed Goals and Objectives (June 6, 2012), *available at* http://www.unep.org/geo/.
52. United Nations Environment Programme, Global Environment Outlook 21-22 (5th ed. 2012).
53. *See*, *e.g.*, A.D. Barnosky et al., *Approaching a State Shift in Earth's Biosphere*, 486 Nature 52, 55-56 (June 7, 2012).
54. *Author's Note*: This section draws heavily from works previously published with Melinda Harm Benson, to whom I am greatly indebted. *See generally* Craig & Benson, *supra* note 9; Benson & Craig, *supra* note 36.
55. U.S. Climate Change Science Program, Synthesis & Assessment Product 4.2: Thresholds of Climate Change in Ecosystems ix (Jan. 2009) [hereinafter 2009 USCCSP Ecosystem Thresholds Report].
56. *See generally* Benson & Craig, *supra* note 36; *see also* Craig & Benson, *supra* note 9, at 862-78; Craig Anthony (Tony) Arnold & Lance H. Gunderson, *Adaptive Law and Resilience*, 43 ELR 10426, 10426-30 (May 2013); Barbara

First, resilience theory acknowledges that both ecosystems and socioecological systems are complex systems that behave in unpredictable ways, rather than mere assemblages whose components can be successfully managed independently of one another. Complex systems exhibit complex collective behavior—that is, individual components, following readily discernible rules of behavior, act collectively in vast numbers to "give rise to the complex, hard-to-predict, and changing patterns of behavior that fascinate us."[57] This property is often referred to as the *self-organizing* nature of complex systems, and the difficult-to-predict results are deemed *emergent* behaviors or properties.[58] In addition, complex systems exhibit signaling and information processing—that is, they "produce and use information and signals from both their internal and external environments."[59] As a result, complex systems are linked systems, both temporally and spatially, and they exhibit feedback through these linkages.[60] Finally, complex systems "adapt—that is, change their behavior to improve their chances of survival or success—through learning or evolutionary processes."[61] As a result, complex systems—sometimes more specifically referred to as "complex adaptive systems"[62]—are dynamic systems because "they change over time in some way."[63]

Second, resilience theory focuses, as the name suggests, on the resilience of complex systems in the face of continual change, rather than on maintenance of those systems in human-defined "ideal" states. According to ecological resilience scholar C.S. "Buzz" Holling, "resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb change of state variables, driving variables, and parameters, and still persist."[64] Ecological resilience can be characterized by: (1) the amount of change the system can undergo and still retain the same controls on function and structure; (2) the degree to which the system is capable of self-organization; and (3) the ability to build and increase the capacity for learning and adaptation. These three characteristics provide the basic foundations of resilience theory.

Admittedly, resilience theory can sometimes sound like another version of sustainability, because one aspect of resilience theory emphasizes a system's capacity to absorb change without shifting into a qualitatively different state (resilience in the first sense above).[65] The dynamic capabilities of complex systems, combined with their emergent behaviors, can give these systems a certain degree of resilience in this first sense. Specifically, the emergent properties that such systems display typically are "the result of a very powerful organizing force that can overcome a variety of changes to the lower-level components."[66] Thus, "[w]hile complex systems can be fragile, they can also exhibit an unusual degree of robustness to less radical changes in their component parts."[67]

This is the resistance end of the resilience thinking continuum—the end of the continuum that is closest to stationarity and sustainability because it emphasizes the capacity of complex systems to maintain functions and remain in certain overall states of being—i.e., to remain, in at least some senses, "the same." Closely related to the resistance end of resilience thinking, moreover, is adaptive capacity. According to the IPCC,

> Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies. The presence of adaptive capacity has been shown to be a necessary condition for the design and implementation of effective adaptation strategies so as to reduce the likelihood and the magnitude of harmful outcomes resulting from climate change. Adaptive capacity also enables sectors and institutions to take advantage of opportunities or benefits from climate change, such as a longer growing season or increased potential for tourism.[68]

Notably, however, even at the resistance end of the resilience continuum, resilience thinking acknowledges the non-transformative changes that always affect complex systems. More importantly, and in sharp distinction from sustainability, resilience thinking also always recognizes that when events or system processes are altered in

Cosens, *Resilience and Law as a Theoretical Backdrop for Natural Resource Management: Flood Management in the Columbia River Basin*, 42 Envtl. L. 241, 245-47 (2012); Robin Kundis Craig, *Ocean Governance for the 21st Century: Making Marine Zoning Climate Change Adaptable*, 36 Harv. Envtl. L. Rev. 305, 333-41 (2012); Robin Kundis Craig, *Legal Remedies for Deep Marine Oil Spills and Long-Term Ecological Resilience: A Match Made in Hell*, 2011 B.Y.U. L. Rev. 1863, 1886-97 (2011); J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems—With Applications to Climate Change Adaptation*, 89 N.C. L. Rev. 1373, 1374-78, 1393-1402 (2011); Barbara Cosens, *Transboundary River Governance in the Face of Uncertainty: Resilience Theory and the Columbia River Treaty*, 30 J. Land, Resources & Envtl. L. 229, 231-42 (2010); Robert W. Adler, *Resilience, Restoration, and Sustainability: Revisiting the Fundamental Principles of the Clean Water Act*, 32 Wash. U. J.L. & Pol'y 139, 142-50 (2010); Sandra Zellmer & Lance Gunderson, *Why Resilience May Not Always Be a Good Thing: Lessons in Ecosystem Restoration From Glen Canyon and the Everglades*, 87 Neb. L. Rev. 893, 896-900 (2009); Patrice H. Kunesh, *Constant Governments: Tribal Resilience and Regeneration in Changing Times*, 19 Kan. J.L. & Pub. Pol'y 8, 13-14 (2009); J.B. Ruhl, *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 B.U. L. Rev. 1, 17-23 (2008).

57. Melanie Mitchell, Complexity: A Guided Tour 12 (2009). *See also* Neil Johnson, Two's Company, Three Is Complexity 13, 15 (2007) (noting that a complex system "contains a collection of many interacting objects or 'agents,'" that it "exhibits emergent phenomena which are generally surprising, and may be extreme," and that "the emergent phenomena typically arise in the absence of any sort of 'invisible hand' or central controller").
58. Mitchell, *supra* note 57, at 13; *see also* John H. Miller & Scott e. Page, Complex Adaptive Systems: An Introduction to Computational Models of Social Life 9 (2007) ("The behavior of many complex systems emerges from the activities of lower-level components."); Johnson, *supra* note 57, at 5-9 (discussing emergent behavior and giving examples from a number of areas).
59. Mitchell, *supra* note 57, at 13.
60. Johnson, *supra* note 57, at 14.
61. Mitchell, *supra* note 57, at 13. *See also* Johnson, *supra* note 57, at 14 ("The objects can adapt their strategies according to their history.").
62. Mitchell, *supra* note 57, at 13.
63. *Id.* at 15.
64. C.S. Holling, Resilience and Stability of Ecological Systems 17 (1973).
65. Stephen B. Carpenter et al., *From Metaphor to Measurement: Resilience of What to What?*, 4 Ecosystems 765, 766 (2001).
66. Miller & Page, *supra* note 58, at 9.
67. *Id.*
68. 2007 IPCC Adaptation Report, *supra* note 8, at 727.

ways that go beyond the system's capacity to absorb those changes, the system can "flip" into a new system state.[69] This result is often referred as *regime change* and represents the transformative end of the resilience thinking continuum. Indeed, one of the important lessons from resilience theory for governance institutions in a climate change era is that uncertainty and unpredictability are inherent limitations on the legal system's ability to perfectly control and regulate its subjects, whether those subjects be social systems, ecological systems, or the important and dynamic intersection of the two, generally referred to as socioecological systems.[70] As John Miller and Scott Page have emphasized, "At the most basic level, the field of complex systems challenges the notion that by perfectly understanding the behavior of each component part a system we can then understand the system as a whole."[71] Or, as Neil Johnson has more colorfully summarized, complexity theory (including resilience theory) "represents a slap in the face for traditional reductionist approaches to understanding the world."[72] Applying this insight to American environmental law, Barbara Cosens notes that "[n]atural resource management for optimization of ecosystem services with immediate commodity value, such as energy, timber, or large game, does not lead to resilience or sustainability of an ecosystem."[73]

Thus, unlike the sustainability principle, resilience theory recognizes that "a management focus that seeks to stabilize a selected set of values or products tends instead to actually increase system vulnerability to shocks and perturbations," making change more likely.[74] More generally, resilience thinking "is always about coping with change."[75] Unlike sustainability, it assumes—even at the resistance end of the spectrum—that systems are continually responding and adapting to continual change, with the ever-present possibility that the changes will cross a threshold and induce an abrupt regime shift in the system. As such, resilience thinking acknowledges a continuum of possible system responses to change, ranging from fairly complete resistance to a particular perturbation to complete transformation.[76] Resilience theory is thus a much better paradigm for the climate change era than sustainability, and it should be adopted as such.

2. Recognize and Emphasize That No Private Right Is Absolute and That Private Interests Must Yield to Community Survival. American culture has tended to "embrace[ ] minimal government and maximal individual liberty."[77] Two manifestations of this tendency are popular conceptions of private property rights as "absolute,"[78] while fear of constitutional "takings" liability inspires at least some governments to drag their proverbial feet in implementing necessary climate change measures.[79] Over-attentiveness to private rights at the expense of public needs, however, can impede effective adaptation to climate change,[80] which is likely to require a more community-based and publicly-minded governance system.[81] Climate change adaptation will thus require several alterations in cultural norms,[82] one of the most important of which will be the reassertion of community and public values, even if they come at the occasional expense of individual property rights and liberties.[83]

Private real property rights in the United States are likely to produce some of the greatest sticking points in adapting to climate change in the United States. Indeed, when the IPCC reported in 2007 on climate change adaptation measures in the United States, it emphasized state land acquisition programs[84]—that is, programs that actively convert private land into public land. Placing land in public ownership makes the implementation of land-based adaptation measures easier,[85] but it implicitly assumes that governance

69. C.S. Holling, *Engineering Resilience Versus Ecological Resilience*, *in* Engineering Within Ecological Constraints 36 (P. Schulze ed., 1996).
70. Craig & Benson, *supra* note 9, at 864-68.
71. Miller & Page, *supra* note 58, at 3.
72. Johnson, *supra* note 57, at 17.
73. *See* Cosens, *Resilience and Law as a Theoretical Backdrop*, *supra* note 5, at 245-46.
74. *Id.*
75. Craig & Benson, *supra* note 9, at 865.
76. Rob Fischman, *Public Lands Management*, Northwestern University School of Law Climate Change Roundtable, Chicago, Illinois (Oct. 5, 2012) (conference presentation); *see also* Craig & Benson, *supra* note 9, at 866.
77. Lawrence D. Brown & Lawrence R. Jacobs, The Private Abuse of the Public Interest: Market Myths and Policy Muddles 128 (2008).
78. Christine A. Klein, *The New Nuisance: An Antidote to Wetland Loss, Sprawl, and Global Warming*, 48 B.C. L. Rev. 1155, 1158-67 (2007).
79. *See*, *e.g.*, Darren Botello-Samson, *Lawsuits, Property, and the Environment: Measuring the Impact of Regulatory Takings Litigation on Surface Mining Permits*, 2006 Annual Meeting of the American Political Science Association, at 2, 42-43 (Aug. 2006), *available at* http://www.allacademic.com//meta/p_mla_apa_research_citation/1/5/1/9/7/pages151975/p151975-1.php (suggesting that regulatory takings litigation can have a chilling effect on environmental and natural resources regulation).
80. Craig, *supra* note 33, at 61-64.
81. As researchers have acknowledged:
> Although not a panacea, community engagement may offer a means of reducing vulnerability to the natural hazards associated with climate change. Critiques of how participatory planning is applied have highlighted its frequent lack of consideration for ecosystem heterogeneity and intracommunity dynamics as well as the differential access to resources inherent in some community-based management.

Emma L. Tompkins & W. Neil Adger, *Does Adaptive Management of Natural Resources Enhance Resilience to Climate Change?*, 9 Ecology & Soc'y 10, 11 (2004) (internal references omitted).
82. *See*, *e.g.*, *id.* at 11 ("Action to adapt and maintain resilience in the face of climate change requires adjustments by governments, by individuals acting as citizens and through market exchange, and by civil society through collective action."), 12 ("[N]ot all ways of adapting to climate change are in harmony with existing social norms, institutions, and structures.").
83. Craig, *supra* note 33, at 61.
84. 2007 IPCC Adaptation Report, *supra* note 8, at 722 tbl. 17.1. Specifically, the Report highlighted "[l]and acquisition programmes taking account of climate change (*e.g.*, New Jersey Coastal Blue Acres land acquisition programme to acquire coastal lands damaged/prone to damages by storms or buffering other lands; the acquired lands are being used for recreation and conservation); establishment of a 'rolling easement' in Texas, an entitlement to public ownership of property that 'rolls' inland with the coastline as sea-level rises; other coastal policies that encourage coastal landowners to act in ways that anticipate sea-level rise." *Id.*; *see also* Western Governors' Ass'n, Western Wildlife Habitat Council Established 6 (2008), *available at* http://www.westgov.org/wga/publicat/wildlife08.pdf ("Wildlife conservation on private lands is best accomplished through the use of incentives and tools that encourage and facilitate private landowners and private industry to achieve conservation objectives.").
85. *See* Robert L. Glicksman, *Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management*, 87 Neb.

institutions must compensate private landowners for climate change adaptation measures. This assumption could both increase the cost of climate change adaptation measures for governments and reify the stationarity-based assumption that private property rights are absolute *even in the face of radically changing environmental conditions that have significant public safety and health implications*. As will be noted, a variety of common-law doctrines undermine the legal foundations of this assertion of property rights seasickness. Nevertheless, property rights seasickness remains a significant impediment to effective climate change adaptation.

Indeed, lest that concern seem overly pessimistic, the emerging conflict between public/community-minded reactions to changing conditions and private property rights is already being fought along the nation's coasts.[86] Climate change impacts include both rising seas and increasingly severe coastal storms, both of which have significant implications for coastal property development and the regulation of the coastal zone. It is therefore no accident that one of the most prominent regulatory "takings" cases in the U.S. Supreme Court involved state restrictions on development designed to cope with a shifting coastline.[87] Similar litigation is playing out in a number of coastal states that are trying to regulate and limit coastal development, including California,[88] Florida,[89] Hawai'i,[90] Maryland,[91] Massachusetts,[92] New Jersey,[93] Texas,[94] and Washington.[95] Whether regulatory approaches to coastal development and use designated more specifically as climate change adaptation measures can be insulated from similar legal challenges remains an open question.[96]

Nevertheless, United States law contains several, now often-dormant, doctrines that underscore the occasional primacy of public and community values. These doctrines need to be revitalized to provide a more productive and community-protective balancing of private and public rights and values in the course of climate change adaptation. Public nuisance law remains the most widely employed of these doctrines and prevents uses of private land or other private actions that interfere with public rights and values.[97] The public trust doctrine is experiencing a resurgence in many states and, most generally, protects the general public's right to use common resources such as navigable waters and the coast.[98] The public trust doctrine can vary considerably from state to state, however, and many states protect more general ecological values as well as public rights to use water.[99] In addition, for climate change purposes, a number of states are recognizing (or at least contemplating recognizing) a public trust in the air or atmosphere that might be offended by increasing greenhouse gas concentrations and failure to engage in climate change mitigation.[100]

Finally, the most dormant of these legal doctrines is the public necessity doctrine, which provides that in times of true emergency or public necessity, private rights fall to public need.[101] Even the U.S. Supreme Court has noted that "the common law had long recognized that in times of imminent peril—such as when fire threatened a whole community—the sovereign could, with immunity, destroy the property of a few that the property of many and the lives of many more could be saved."[102] If climate change adaptation can be reconceived of as a response to a series of impending emergencies, the doctrine of public necessity may emerge as an importance legal support for commu-

L. Rev. 833, 877-81 (2009) (discussing the federal government's potential uses of the Property Clause and condemnation authority to protect public lands and their ecosystems in an era of climate change).

86. *See*, *e.g.*, Craig Anthony (Tony) Arnold, *Legal Castles in the Sand: The Evolution of Property Law, Culture, and Ecology in Coastal Lands*, 61 Syracuse L. Rev. 213, 214 (2011) (arguing that "property law and takings cases can be maladaptive to the evolutionary dynamics of coastal lands when they fail to contemplate the ecological and social conditions and dynamics of the objects of property rights and takings claims.").
87. Lucas v. S.C. Coastal Council, 505 U.S. 1003 (1992).
88. *E.g.*, Reddell v. Cal. Coastal Comm'n, 180 Cal. App. 4th 956 (2009).
89. *E.g.*, Walton County v. Stop the Beach Renourishment, Inc., 998 So. 2d 1102 (Fla. 2008), *aff'd sub nom.* Stop the Beach Renourishment, Inc. v. Fla. Dept. of Envtl. Protection, 130 S. Ct. 2592 (2010).
90. *E.g.*, Leone v. County of Maui, 284 P.3d 956 (Haw. App. 2012).
91. *E.g.*, McHale v. DCW Dutchship Island, L.L.C., 999 A.2d 969 (Md. 2010).
92. *E.g.*, Giovanella v. Conservation Comm'n of Ashland, 857 N.E.2d 451 (Mass. 2006).
93. *E.g.*, Borough of Harvey Cedars v. Karan, 70 A.3d 524 (N.J. 2013).
94. *E.g.*, Severance v. Patterson, 370 S.W.3d 705 (Tex. 2012).
95. *E.g.*, Kitsap Alliance of Property Owners v. Central Puget Sound Growth Mgmt. Hearings Bd., 255 P.3d 696 (Wash. App. 2011).
96. Arnold, *supra* note 86, at 254-59; Robin Kundis Craig, *Public Trust and Public Necessity Defenses to Taking Liability for Sea-Level Rise Responses on the Gulf Coast*, 26 J. Land Use & Envtl. L. 395, 399-431 (2011).
97. *See*, *e.g.*, Michael C. Blumm & Lucus Ritchie, Lucas*'s Unlikely Legacy: The Rise of Background Principles as Categorical Takings Defenses*, 29 Harv. Envtl. L. Rev. 321, 331-41 (2005) (describing the role of public nuisance as a limitation on private property rights); Klein, *supra* note 78, at 1158-67.
98. *See*, *e.g.*, California v. Super. Ct. Placer County, 625 P.2d 256, 260 (Cal. 1981) (upholding the public interest in public trust protections for shore lands and noting that "[p]reservation of the public trust in the shore zone will allow the state the flexibility in determining the appropriate use of such land").
99. *See generally* Robin Kundis Craig, *A Comparative Guide to the Western States' Public Trust Doctrines: Public Values, Private Rights, and the Evolution Toward an Ecological Public Trust*, 37 Ecology L.Q. 53 (2010); Robin Kundis Craig, *A Comparative Guide to the Eastern Public Trust Doctrines: Classifications of States, Property Rights, and State Summaries*, 16 Penn. State Envtl. L. Rev. 1 (2007) (collectively summarizing all 50 states' public trust doctrines).
100. *E.g.*, Conn. Gen. Stat. Ann. §§22a-16 to 22a-17 (2012) (recognizing a public trust in the air); Butler ex rel. Peshlakai v. Brewer, 2013 WL 1091209, *1, **5-6 (Ariz. App. Mar. 14, 2013) (contemplating whether Arizona's public trust doctrine extends to the atmosphere); Bonser-Lain v. Texas Comm'n on Envtl. Quality, No. D-1-GN-11-002194 (201st Jud. Dist. Ct. Travis Cty. Tex. July 9, 2012) (holding that the Texas public trust doctrine extends to all natural resources, including the atmosphere), *letter ruling available at* http://ourchildrenstrust.org/sites/default/files/Texas-letter-ruling_0.pdf; Sanders-Reed v. Martinez, No. D-101-CV-2011-01514 (1st Jud. Dist. Ct. N.M. July 14, 2012) (dealing with plaintiffs' lawsuit to bring greenhouse gas emissions within New Mexico's public trust doctrine and air quality laws), *available at* http://ourchildrenstrust.org/sites/default/files/Order%20Denying%20Motion%20to%20Dismiss.pdf.
101. "At such times, the individual rights of property give way to the higher laws of impending necessity." Surocco v. Geary, 3 Cal. 69, 73 (1853).
102. United States v. Caltex, Inc., 344 U.S. 149, 154 (1952), *rehearing denied*, 344 U.S. 919 (1953). Prosser explains further:

> Where the danger affects the entire community, or so many people that the public interest in involved, that interest serves as a complete justification to the defendant who acts to avert the peril to all. . . . This notion does not require the "champion of the public" to pay for the general salvation out of his own pocket. The number of persons who must be endangered in order to create a public necessity has not been determined by the courts.

Prosser & Keeton, The Law of Torts §24 (5th ed. 1984) (footnote omitted).

nity-based adaptation strategies that impinge on private rights, especially private property rights.[103]

As Christine Klein has noted, "In a healthy society, there is a rough give-and-take between individual autonomy and community well-being."[104] In an unhealthy, stressed, or war-ravaged society, in contrast, the balance tends to tip sharply in favor of preservation of the community, allowing for measures such as quarantine, rationing, and the suspension of habeas corpus. Like war and epidemic diseases, climate change adaptation could well become a matter of community survival. As such, it warrants rebalancing of public and private interests. Climate change is also likely to make obvious the fact that, as Lawrence Brown and Lawrence Jacobs have recognized, "Far from comprising the neat, bounded minimum package of government responsibilities that market promoters have imagined, public good evolve in response to new demands and disputes about what the public interest requires."[105] Reinvigorating the public necessity doctrine for climate change adaptation, supported by increased use of public nuisance law and expanded public trust doctrines, would reenvision the relationship between private rights and public rights/community need in ways that could more productively support climate change adaptation than a continued clinging to sustainability goals.

3. Stop Avoiding the Subject of Human Population Growth. Another continual change problem that has always interfered with sustainability (especially in terms of resource and energy consumption), and which exacerbates the continual change that climate change is bringing, is population growth. Fewer people make all resource distribution issues easier, and the same would be true in a climate change era. However, while in 1950 the world had 2.5 billion people, by 2005 that number had risen to 6.5 billion.[106] Somewhere between October 2011 and March 2012, world population hit 7 billion people,[107] and most projections estimate that humans will number more than 9 billion by 2050.[108]

Beside adding to the continual change that characterizes the climate change era, human population growth is also an impediment to dealing with climate change, in terms of both mitigation (more humans generally means more energy consumption and clearing of forests, both of which increase greenhouse gas emissions) and adaptation (the more crowded the planet, the less flexibility there is in terms of moving people around and adapting new lifestyles, especially if one goal remains to avoid destroying ecosystems at the same time).[109] On the adaptation side, John Guillebaud and Pip Hayes noted in 2008 that "[t]he world's population now exceeds 6,700 million, and humankind's consumption of fossil fuels, fresh water, crops, fish, and forests exceeds supply. These facts are connected. The annual increase in population of about 79 million means that every week an extra 1.5 million people need food and somewhere to live."[110] As for mitigation, in 2009 Paul Murtaugh and Michael Schlax detailed the fact that childbearing is decidedly *not* a carbon-neutral activity, although the exact impact varies considerably depending on emissions and reproduction assumptions and the mother's country of residence.[111] Nevertheless, under a constant emissions scenario, a woman in the United States who has two children would be responsible for adding close to 19,000 tons of carbon dioxide to the Earth's atmosphere over time.[112]

Serious talk about population growth in the legal and governance context, however, is in short supply. And, to be sure, active control of population growth through legal mandates limiting childbearing is a *bad* idea, for human rights, cultural, religious, and practical enforcement reasons. Similarly, concerns over population growth should not be used as an excuse to "punish" children already in existence by denying them (positively or through indifference) food, water, sanitation, health care, and education.

On the other hand, we don't have to reward parents who choose to have large families. Economic studies suggest that tax policies and other incentives can influence national fertility rates,[113] and several European countries are actively incentivizing families to have more children.[114] While the impact of federal tax exemptions on fertility rates in the United States is murkier,[115] these incentives nevertheless convey exactly the wrong message about having children in a climate change era, regardless of whether your framework is sustainability or resilience thinking. Nevertheless, in February 2013, *The Wall Street Journal*

103. Craig, *supra* note 96, at 419-31; Robin Kundis Craig, *Adapting Water Law to Public Necessity: Reframing Climate Change Adaptation as Emergency Response and Preparedness*, 11 Vermont J. Envtl. L. 709, 714-17, 735-52 (2010).
104. Klein, *supra* note 78, at 1158.
105. Brown & Jacobs, *supra* note 77, at 103.
106. Population Reference Bureau, *World Population Growth, 1950–2050*, http://www.prb.org/Educators/TeachersGuides/HumanPopulation/PopulationGrowth.aspx (last visited May 24, 2013).
107. Worldometers, *Current World Population*, http://www.worldometers.info/world-population/ (last visited May 24, 2013). The United Nations estimated that the world population reached 7 billion on October 31, 2011. United Nations Department of Economic & Social Affairs, *World Population Prospects, the 2010 Revision: Frequently Asked Questions*, http://esa.un.org/wpp/Other-Information/faq.htm#q4 (last visited Oct. 31, 2011). The U.S. Census Bureau, in contrast, estimated that the world population did not reach 7 billion until March 12, 2012. Daniel Goodkind, Population Division, U.S. Census Bureau, *World Population at 7 Billion*, http://blogs.census.gov/2011/10/31/the-world-population-at-7-billion/ (Oct. 31, 2011).
108. Population Reference Bureau, *supra* note 106; Goodkind, *supra* note 107.
109. *E.g.*, Center for Biological Diversity, *Human Population Growth and Climate Change*, http://www.biologicaldiversity.org/campaigns/overpopulation/climate/ (last visited May 24, 2013) (noting that "unsustainable human population growth can overwhelm [climate change mitigation] efforts, leading us to conclude that we not only need smaller footprints, but fewer feet).
110. John Guillebaud & Pip Hayes, *Population Growth and Climate Change*, 337 Brit. Med. J. 39575, 39575 (2008).
111. Paul A. Murtaugh & Michael G. Schlax, *Reproduction and the Carbon Legacies of Individuals*, 19 Global Envtl. Change 14, 16-18 (2009).
112. *Id.* at 18.
113. *E.g.*, Alma Cohen et al., *Do Financial Incentives Affect Fertility?*, National Bureau of Economic Research Working Paper No. 13700 (as revised May 26, 2009), *available at* http://www.nber.org/papers/w13700 (finding such a connection in Israel).
114. Elizabeth Bryant, *European Nations Offer Incentives to Have Kids*, S.F. Chron., Aug. 10, 2008; Stephen Graham, *Germans Get Incentives for Having Babies*, Wash. Post, Jan. 3, 2007; *France Offers an Incentive for 3rd Child*, N.Y. Times, Sept. 23, 2005.
115. Richard Crump et al., *Fertility and the Personal Exemption: Comment*, 101 Amer. Econ. Rev. 1616, 1616-18 (2011).

openly bemoaned the falling fertility rate in the United States, figuring it as a direct threat to the nation's political standing in the world.[116]

Realigning incentives and adjusting cultural messaging aren't the only non-regulatory measures that could address population growth. As many social scientists have recognized, reduced population levels often follow from improving the social, economic, and educational status of women and girls. This recognition provides a route whereby efforts to control human population growth can dovetail neatly with efforts to improve human rights and human quality of life throughout the world. As *Scientific American* summarized in 2009:

> Many population experts believe the answer lies in improving the health of women and children in developing nations. By reducing poverty and infant mortality, increasing women's and girls' access to basic human rights (health care, education, economic opportunity), educating women about birth control options and ensuring access to voluntary family planning services, women will choose to limit family size.[117]

The point here is not to advocate for a particular political agenda, per se, but rather to argue that the legal and governance institutions cannot adequately respond to our new climate change reality without talking about population. To pursue sustainability goals while avoiding the messy politics of population growth was always already an exercise in futility; climate change means the death of sustainability while simultaneously making the population issue even more imperative.

Perhaps paradoxically, adopting the new norm that we need to adopt for climate change—i.e., becoming landsick—might also provide a helpful new framework for dealing with population growth, which in turn would ease some of the pain inflicted in adapting to climate change. Evidence indicates that birth rates in developed countries decline during perceived crises—the Great Depression,[118] the oil crisis of the 1970s,[119] the economic crisis of 2008.[120] Moreover, some aspects of "westernizing" developing countries (together with improved status for women) appears to be connected to declining birth rates in certain developing nations.[121] Perhaps, maybe, we can all slowly become landsick together.

V. Accepting Change as the New Normal

In the meantime, however, both climate change and rising population require that we accept perpetual change as the new normal—that we acquire, as quickly as possible, our climate change sea legs. Ecosystems are changing under our feet, with real economic consequences. Insurance companies are already reassessing their risk assumptions, spurred not just by major catastrophes such as the 2005 hurricane season in the Gulf of Mexico (including Hurricane Katrina), Superstorm Sandy, and the enormous tornadoes touching down inland but also less obvious increased liabilities from climate change impacts. A variety of industries and municipalities are reevaluating their futures because of ongoing and predicted changes in water resources.

It's time for the law and the general public to catch up with these realities instead of stubbornly clinging to the paradigm of stationarity and the pipedream of sustainability. Without climate change sea legs, we will simply continue to resist and become confused by the many impacts rocking our world, condemning ourselves—and probably our children and grandchildren—to misery. With them, however, we might just be able to ride the swell into a productive—if very different—future.

116. Jonathan V. Last, *America's Baby Bust*, Wall St. J., Feb. 1, 2013, at C1.
117. EarthTalk, *Does Population Growth Impact Climate Change?*, Sci. Am., July 29, 2009; *see also* Anushay Hossain, *Seven Billion People and Women's Rights: What's the Connection?*, Forbes.com, Oct. 29, 2011 (arguing that "the whole world will reap the rewards" if women get control of their own fertility).
118. Mark Mather, *Fact Sheet: The Decline in U.S. Fertility*, http://www.prb.org/Publications/Datasheets/2012/world-population-data-sheet/fact-sheet-us-population.aspx (as viewed Dec. 5, 2013).
119. *Id.*
120. *Id.* In addition, in Europe, "[t]he Max Planck Institute for Demographic Research in Germany found that the birth rate in 28 European countries dropped as unemployment rose." *Europe Birth Rates "Have Fallen" Since Economic Crisis*, BBC News Europe, July 10, 2013.
121. Brad Plummer, *Why Are Birthrates Falling Around the World? Blame Television*, Wash. Post, May 13, 2013.