

COME HELL AND HIGH WATER: COPING WITH THE UNAVOIDABLE CONSEQUENCES OF CLIMATE DISRUPTION

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BACKGROUND

Global climate change is not only “unequivocal” as the IPCC Fourth Assessment proclaimed,¹ it is happening now, it is accelerating, and no one knows for sure what lies ahead as the nations of the world struggle in a race against time to achieve an unprecedented level of cooperation on greenhouse gas limits before it is, literally, too late to save humanity.² The polar ice caps, the Arctic, and massive glaciers in the Himalayas and Andes are melting faster than predicted;³ sea levels are rising faster than predicted;⁴ the ocean is slowly turning acidic;⁵ tropical storms are intensifying;⁶ saltwater is contaminating coastal aquifers and degrading estuaries;⁷ lake levels are dropping;⁸ runoff is increasing;⁹ flood peaks are

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1. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 30 (Core Writing Team, R.K. Pachauri & A. Reisinger eds., 2007) [hereinafter IPCC 2007], available at http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm (follow “full report”).

2. See U.S. GLOBAL CLIMATE CHANGE RES. PROG., GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 12, 27 (Thomas R. Karl, Jerry M. Melillo & Thomas C. Peterson eds., 2009) [hereinafter GLOBAL CLIMATE CHANGE], available at <http://downloads.globalclimatechange.gov/usimpacts/pdfs/climate-impacts-report.pdf>. Among the key findings, the Program found:

Climate-related changes are already observed in the United States and its coastal waters. These include increases in heavy downpours, rising temperature and sea level, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the ocean and on lakes and rivers, earlier snowmelt, and alterations in river flows.

Id.

3. See Press Release, Lisa Mastny, Worldwatch Institute, Melting of Earth’s Ice Cover Reaches New High (Mar. 6, 2000), <http://www.worldwatch.org/node/1673> (describing ice melt and rising water levels around the globe).

4. *Id.*

5. Professor James Lovelock, Address at the Royal Society, Climate Change On the Living Earth (Oct. 29, 2007) (draft speech), available at <http://royalsociety.org/climate-change-on-the-living-earth-29-october-2007>.

6. Kerry Emanuel, *Increasing destructiveness of tropical cyclones over the past 30 years*, 436 NATURE 686, 686 (2005).

7. S. Zektser, H. A. Loáiciga, & J. T. Wolf, *Environmental impacts of groundwater overdraft: selected case studies in the southwestern United States*, 47 ENVTL. GEOLOGY 396, 396 (2005).

8. *Id.*

9. See Huang-jia Huang et al., *Effect of growing watershed imperviousness on hydrograph parameters and peak discharge*, 22 HYDROLOGICAL PROCESSES 2075, 2075–76 (2008) (describing

growing;¹⁰ droughts are intensifying;¹¹ wildfires are spreading;¹² pests and invasive species are expanding;¹³ diseases are moving into population centers;¹⁴ ecosystems are shifting poleward and upward;¹⁵ migratory species patterns are changing;¹⁶ coldwater habitat is shrinking;¹⁷ and more deadly heatwaves are expected.¹⁸ And none of that takes into account the potential for abrupt climate change which could unleash truly catastrophic, Hollywood disaster movie scenarios.¹⁹

The math is sobering. Average global temperatures have increased by 0.74°C (1.3°F) within the past 100 years and are the highest they have been in over 10,000 years.²⁰ Atmospheric concentrations of carbon dioxide (CO₂), which have increased 38% from pre-industrial levels, are the highest they have been in over 650,000 years of earth's geologic history.²¹ Today

growing flood peaks amid other effects).

10. *Id.*

11. See Aiguo Dai et al., *A Global Dataset of Palmer Drought Severity Index for 1870–2002: Relationship with Soil Moisture and Effects of Surface Warming*, 5 J. HYDROMETEOROLOGY 1117, 1117 (2004) (describing drought conditions resulting from anthropocentric climate influences).

12. See Janet Larsen, Dir. of Research, Earth Policy Inst., *Inferno on Earth: Wildfires Spreading as Temperatures Rise* (Nov. 19, 2009), http://www.earth-policy.org/index.php?plan_b_updates/2009/update85 (describing connection between the increase of wildfires and rising temperature).

13. Jesse A. Logan, U.S. Dep't Agric. Forest Serv., *Climate Change Induced Invasions by Native and Exotic Pests*, in PROCEEDINGS 17TH U.S. DEPARTMENT OF AGRICULTURE INTERAGENCY RESEARCH FORUM ON GYPSY MOTH AND OTHER INVASIVE SPECIES 8, 8–13, (Kurt W. Gottschalk ed., 2006).

14. See António Guterres, U.N. High Comm'r for Refugees, *Climate Change, Natural Disasters and Human Displacement: A UNHCR Perspective* 7 (2009), available at http://www.globalmigrationgroup.org/pdf/UNHCR_Policy_Paper_Climate_Change.pdf (describing changed disease patterns based on varied increased populations in cities).

15. See STEVEN W. RUNNING & L. SCOTT MILLS, RESOURCES FOR THE FUTURE, TERRESTRIAL ECOSYSTEM ADAPTATION 15 (2009), available at <http://www.rff.org/RFF/Documents/RFF-Rpt-Adaptation-RunningMills.pdf> (describing how species have adapted by shifting their habitats to areas with fewer stressors).

16. *Id.*

17. See STEVEN KINSELLA ET AL., NATURAL RESOURCES DEFENSE COUNCIL, TROUT IN TROUBLE: THE IMPACTS OF GLOBAL WARMING ON TROUT IN THE INTERIOR WEST 5, 11 (2008) available at <http://www.nrdc.org/globalwarming/trout/trout.pdf> (discussing recent changes in snowmelt affecting stream temperatures).

18. See Press Release, Scripps Inst. of Oceanography, *Deadly Heat Waves are Becoming More Frequent in California* (Aug. 25, 2009), <http://scrippsnews.ucsd.edu/Releases/?releaseID=1018> (predicting more frequent large scale heat waves in California while describing mechanistic causes more generally).

19. See WALLACE S. BROECKER & ROBERT KUNZIG, *FIXING CLIMATE* 138 (2008) (describing the movie *THE DAY AFTER TOMORROW* (Twentieth Century Fox 2004), which depicts a sudden ice age, a fictional account of abrupt climate change, and is based on potential slowing or shutdown of thermohaline ocean circulation).

20. Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18,886, 18,896 (Apr. 24, 2009).

21. *Id.* at 18,895–96.

these concentrations are 386 parts per million.²² According to the IPCC, it is “very likely” (i.e. over 90% certainty) that anthropogenic emissions of CO₂ and other greenhouse gases are responsible for this temperature increase.²³ Worse, due to the longevity of CO₂ in the atmosphere, the full effect of the “radiative forcing” has not been felt and average temperatures are expected to rise another 0.5 to 2.8°C under the most optimistic scenarios for limiting green house gases.²⁴ Further, the changes that are underway are essentially irreversible. As a recent report of the National Academy of Sciences puts it, “the climate change that takes place due to increases in carbon dioxide concentration is largely irreversible for 1,000 years after emissions stop.”²⁵ This report goes on to say:

Among illustrative irreversible impacts that should be expected if atmospheric carbon dioxide concentrations increase from current levels near 385 parts per million by volume (ppmv) to a peak of 450–600 ppmv over the coming century are irreversible dry-season rainfall reductions in several regions comparable to those of the “dust bowl” era and inexorable sea level rise.²⁶

The G-7 nations recently expressed the goal of holding the average increase in global temperature to 2°C in order to avoid “dangerous anthropogenic interference with the climate.”²⁷ The Copenhagen Accord addresses this need:

[D]eep cuts in global emissions are required according to science, and as documented by the IPCC Fourth Assessment Report with a view to reduce global emissions so as to hold the increase in global temperature below 2 degrees Celsius, and take action to meet this objective consistent with science and on the basis of equity.²⁸

22. *Id.*

23. IPCC 2007, *supra* note 1, at 40.

24. D. P. Van Vuuren et al., *Temperature increase of 21st century mitigation scenarios*, 105 PROC. NAT'L ACAD. SCI. U.S. 15258, 15258 (2008), available at <http://www.pnas.org/content/105/40/15258.full.pdf+html>. “Notably, an average minimum warming of ≈1.4°C (with a full range of 0.5–2.8°C) remains for even the most stringent stabilization scenarios analyzed here. This value is substantially above previously estimated committed warming based on climate system inertia alone.” *Id.*

25. Susan Solomon et al., *Irreversible climate change due to carbon dioxide emissions*, 106 PROC. NAT'L ACAD. SCI. U.S. 1704, 1704 (2009), available at <http://www.pnas.org/content/106/6/1704.full.pdf+html?sid=819c1042-fab1-4dce-88c7-e2c118f0f904>.

26. *Id.*

27. Copenhagen Accord to the United Nations Framework Convention on Climate Change, Draft Decision -/CP.15, Dec. 18, 2009, para. 1 [hereinafter Copenhagen Accord], available at <http://unfccc.int/resource/docs/2009/cop15/eng/107.pdf>.

28. *Id.* at para. 2.

Barring a political miracle, this goal is probably unattainable given the scale of what needs to be done to “de-carbonize” the global economy over the next few decades. The challenges of reconciling the economic disparities between developed and developing nations are daunting, as demonstrated by the inability to forge a binding new treaty at the recently concluded COP-15 meeting in Copenhagen. President Obama was instrumental in salvaging a last-minute deal among the U.S., China, India, and Brazil.²⁹

The deal calls for these emission cuts by 2020:

- U.S.—17% reduction from 2005 levels (or 3–4 percent from 1990 levels)
- China—40–45% below “business as usual,” that is, judged against 2005 figures for energy used versus economic output
- India—20–25% from 2005 levels
- European Union—20% from 1990 levels (possibly 30%)³⁰

While the Copenhagen Accord commits nations to develop protocols to monitor, report, and verify emissions and calls upon wealthy nations to raise tens of billions of dollars to aid poorer nations in coping with the effects of climate change, it does not establish overall emissions targets for industrialized countries, and the proposed 2020 cuts fall far short of action that scientists say are needed to avoid potentially dangerous effects of climate change.³¹

Suffice it to say it will take many more meetings to hammer out an enforceable agreement that recognizes the “common but differentiated responsibilities” principle established in Article 3.1 of the United Nations Framework Convention on Climate Change.³²

In short, the window of opportunity to prevent serious impacts from climate disruption has closed. The choices now, as President Obama’s Science Advisor, John Holdren, puts it, are to mitigate, adapt, or suffer.³³

29. Andrew C. Revkin & John M. Broder, *Grudging Accord on Climate, Along With Plenty of Discord*, N.Y. TIMES, Dec. 19, 2009, at A1.

30. *Factbox: Over 80 nations sign up to “Copenhagen Accord,”* REUTERS, Feb. 3, 2010, <http://www.reuters.com/assets/print?aid=ustre6124m120100203>.

31. See Revkin & Broder, *supra* note 29 (explaining the outcome of the Copenhagen Summit and the U.S. fallout).

32. United Nations Framework Convention on Climate Change art. 3, June 12, 1992, 1771 U.N.T.S. 107, available at <http://unfccc.int/resource/docs/convkp/conveng.pdf>.

33. John P. Holdren, Chairman, Am. Ass’n for the Advancement of Sci., Meeting the Intertwined Challenges of Energy and Environment (Oct. 29, 2007), available at <http://www.aaas.org/news/releases/2007/1029barnard.shtml>.

To be sure, there is still time to avoid the most catastrophic consequences of climate disruption, although time is fast running out, and no one knows how close we are to the “tipping points” about which many scientists are warning.³⁴ We face a double bind: at the same time that we must step up efforts to mitigate climate change through rapid and steep greenhouse gas reductions (on the order of 50–60% from 1990 levels by 2050 for the world as a whole and 80–90% for the industrialized countries), we will be forced to devote more time, energy, and money to climate adaptation and to relocating the tens of millions (perhaps *hundreds* of millions) “climate refugees” that are projected over the coming years.³⁵

Water resources are in the center of the climate change bull’s-eye.³⁶ Already we are seeing an increase in extreme weather events—more severe droughts and floods, sometimes in the same year in the same area. The pattern of droughts and floods recently experienced in the Southeast offers a glimpse into the future. On September 22, 2009, torrential rains pounded large areas of Georgia.³⁷ As reported by the *New York Times*, Douglas County was “hit by 21 inches of rain from Sunday to Monday, knocking out the drinking water supply to thousands of residents and forcing others to boil their water.”³⁸ During that period, “[a]s much as 15 to 20 inches of rain pounded counties around Atlanta for more than 72 hours”³⁹ Nine people died.⁴⁰ A state climatologist called it “the worst [flooding] . . . in the last 100 years” in some parts of Atlanta.⁴¹ This once-in-a-century flood followed close on the heels of a once-in-a-century drought that struck the same region just two years earlier. As the *New York Times* reported, “[f]or

34. See, e.g., James Hansen, *Tipping Point: Perspective of a Climatologist*, STATE OF THE WILD: 2008–2009 7, 7–9, available at http://www.columbia.edu/~jeh1/2008/StateOfWild_20080428.pdf (describing that tipping points can occur during climate change when the climate reaches a state such that strong, amplifying feedbacks are activated by only moderate additional warming).

35. See Guterres, *supra* note 14 (noting that there were an estimated 20 million climate refugees in 2008 alone).

36. WORKING GROUP II, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION, AND VULNERABILITY 175 (2007) [hereinafter IPCC WG II Report], available at <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter3.pdf> (explaining that all regions will likely experience a “net negative impact of climate change on water resources and freshwater ecosystems[.]” including “reduction in the value of [water resources] services[.] . . . increased precipitation variability and seasonal runoff shifts on water supply, water quality, and flood risks . . .”).

37. Robbie Brown & Liz Robbins, *Rain Stops, but 8 Are Dead in Southeast Floods*, N.Y. TIMES, Sept. 22, 2009, at A14, available at <http://www.nytimes.com/2009/09/23/us/23rain.html>.

38. Robbie Brown, *Georgians Grappling With Flood Damage*, N.Y. TIMES, Sept. 23, 2009, at A23, available at <http://www.nytimes.com/2009/09/24/us/24rain.html>.

39. Brown & Robbins, *supra* note 37, at A14.

40. Brown, *supra* note 38, at A23.

41. Mary Lou Pickel, *It was bigger than a 500-year flood; September deluge was ‘off the charts’ and one of the worst in U.S. history*, ATLANTA J. CONST., Nov. 5, 2009, at A1.

the first time in more than 100 years, much of the Southeast has reached the most severe category of drought, climatologists said Monday, creating an emergency so serious that some cities are just months away from running out of water.⁴² Worst case analyses predicted that Lake Lanier, the main source of water for Atlanta's four million people, could be dry in 90 to 121 days.⁴³ The Governor of North Carolina, Michael F. Easley, called upon the state's residents "to stop using water for any purpose 'not essential to public health and safety.'"⁴⁴

Though no one can prove that climate change caused these back-to-back, once-in-a-century events, they are perfectly consistent with the wild swings in weather patterns predicted by climate models.⁴⁵ As noted climatologist Stephen Schneider has said, "[g]lobal warming will intensify drought . . . [a]nd it will intensify floods."⁴⁶ At a minimum these events offer a cautionary tale about what communities should be thinking about and preparing for as the pace of climate change accelerates. In this vein, I offer some preliminary ideas for using available legal tools to adapt water resource management to meet the challenges of this unprecedented time in human history.

I. EXPANDING THE PUBLIC TRUST DOCTRINE

The venerable public trust doctrine, which traces its roots back through the Magna Carta to the Justinian Code, is recognized in the United States⁴⁷ but apparently has not been fully incorporated into Canadian jurisprudence.⁴⁸ In its simplest formulation, the public trust doctrine (PTD)

42. Brenda Goodman, *Drought-Stricken South Facing Tough Choices*, N.Y. TIMES, Oct. 16, 2007, at A14, available at <http://query.nytimes.com/gst/fullpage.html?res=9b0de7d6163af935a25753c1a9619c8b63&scp=2&sq=drought-stricken%20south%20facing&st=cse>.

43. *Id.*

44. *Id.*

45. Cf. Gabriele C. Hegerl, *Detectability of Anthropogenic Changes in Annual Temperatures and Precipitation Extremes*, 17 J. CLIMATE 3,683, 3,683–84 (2004), available at <http://ams.allenpress.com/archive/1520-0442/17/19/pdf/i1520-0442-17-19-3683.pdf> (discussing climate models' projections for increases in intense precipitation as well as increases in extreme heat events and summer droughts).

46. Doug Struck, *Warming May Exacerbate Global Water Conflicts*, WASH. POST, Aug. 20, 2007, at A8.

47. See *Ill. Cent. R.R. v. Illinois*, 146 U.S. 387, 458–59 (1892) (explaining and adopting the public trust doctrine).

48. *Green v. Ontario*, [1972] 34 D.L.R. 20 (Can.) (denying the existence of a trust that would prevent the Crown from decreasing the area of parklands); RALPH PENTLAND, PUBLIC TRUST DOCTRINE—POTENTIAL IN CANADIAN WATER AND ENVIRONMENTAL MANAGEMENT pmbL., 2 (2009), available at http://poliswaterproject.org/sites/default/files/public_trust_doctrine.pdf (discussing benefits the U.S. has gained from instituting the public trust doctrine and the potential benefits for Canadian water and environmental management if adopted in Canada).

provides that states hold the waters of navigable streams and their non-navigable tributaries, submerged lands, and fishery and wildlife resources in trust for the benefit of all people.⁴⁹ In practice, however, the PTD is not a unitary doctrine; rather, it is a product of the common law heritage of the individual states.⁵⁰ Thus, there is not one PTD but perhaps as many as 50 doctrines.⁵¹ Professor Robin Kundis Craig has surveyed all the states and published a handy compilation divided into Eastern and Western states.⁵² Her survey notes some major differences among the states in the scope, effect, and enforceability of the PTD as applied.⁵³ She describes how the doctrine has evolved over time to address changing conditions and highlights the difficulties involved in balancing private and public rights in water.⁵⁴ Professor Craig has also written an article applying the PTD to climate adaptation.⁵⁵ In this article Professor Craig concludes:

In particular, it notes that courts have long adapted public trust doctrines in the United States to local needs and circumstances, and several states now explicitly characterize their public trust doctrines as evolutionary. With respect to water resources, therefore, these common-law public trust doctrines give willing states a legal vehicle for: (1) acknowledging climate change as a threat to public resources; (2) continually reassessing the cumulative impacts climate change is causing; (3) supporting fledgling adaptive management efforts by state agencies; and, at the extreme, (4) engaging in judicial adaptive management, in the sense of rebalancing private rights and public values in impacted aquatic resources, ecosystems, and ecosystem services.⁵⁶

49. PENTLAND, *supra* note 48, at 3–4.

50. *Id.* at 4.

51. *Id.*

52. Robin Kundis Craig, A Quick and Dirty Guide to the Eastern Public Trust Doctrines: Basic Issues, Classifications of States, and State Summaries (2007) (unpublished manuscript, on file with author) [hereinafter Craig, Eastern Public Trust Doctrines], available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1008161; 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 (2009) (unpublished manuscript, on file with author) [hereinafter Craig, Western States' Public Trust Doctrines], available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1405822.

53. Craig, Eastern Public Trust Doctrines, *supra* note 52, *passim*; Craig, Western States' Public Trust Doctrines, *supra* note 52, *passim*.

54. Craig, Eastern Public Trust Doctrines, *supra* note 52, *passim*; Craig, Western States' Public Trust Doctrines, *supra* note 52, *passim*.

55. Robin Kundis Craig, *Adapting to Climate Change: The Potential Role of State Common-Law Public Trust Doctrines*, 34 VT. L. REV. 781 (2010).

56. *Id.* at 781.

Professor Mary C. Wood has also written eloquently on the subject of the PTD and climate change. In *Nature's Trust*, Professor Wood writes:

The corpus of Nature's Trust encompasses the natural resources vital to our society's welfare and human survival. The trustee is the person who manages the trust for the beneficiaries. Our government, as the only enduring institution with control over human actions, is a trustee of our natural resources. The beneficiaries of this trust are all generations of citizens — past, present, and future. With every trust there is a core duty of protection. This means the trustee must take action to defend the corpus against injury, and where it has been damaged, the trustee must restore the corpus of the trust. The trustee is accountable to the beneficiary, for the beneficiary has a property interest in the corpus of the trust. As trustee, government is accountable to its citizens for handling natural resources that belong to the people.⁵⁷

Whether this expansive view of the PTD will be adopted by the courts or legislatures is an open question. A great deal will depend on where the case is brought and what the facts and circumstances are in specific situations. Facts make law. However, these scholars have articulated a compelling rationale for government and judicial intervention to protect a wide range of natural resources from the effects of climate disruption.

II. HARVESTING STORMWATER

Climate change will increase the intensity and frequency of heavy rainfall events, leading to more polluted runoff, more flooding, more water quality impairment, more waterborne diseases, more loss of aquatic habitat, and other problems.⁵⁸ Traditionally, municipal stormwater has been regarded as a source of pollution to be regulated at the point of discharge.⁵⁹ That will have to change as the sheer volume and costs of trying to capture and treat ever-increasing amount of stormwater through best management practices and other techniques overwhelm municipal and private systems.⁶⁰

57. Mary Christina Wood, 2006 Bioneers Conference Keynote Address, *Nature's Trust: Reclaiming an Environmental Discourse*, 25 VA. ENVTL. L.J. 431, 448–49 (2007) (internal citations omitted), available at <http://www.law.uoregon.edu/faculty/mwood/docs/reclaiming.pdf>.

58. See generally GLOBAL CLIMATE CHANGE, *supra* note 2, at 41–52 (describing more overall precipitation, heavier flooding, increased runoff, diminished water quality, and increased management challenges for water systems globally).

59. Federal Water Pollution Control Act, 33 U.S.C. § 1342(p)(3)(B) (2007).

60. See generally Thomas P. Ballesterio et al., Univ. N.H. Stormwater Ctr., New Hampshire Joint Water and Watershed Conference Presentation, LID Practices as a Means of Resilience and Short-

In fact, in many parts of the country, particularly the arid West, communities are already changing their focus to look at stormwater as a valuable commodity instead of a waste product and designing ways of capturing rainfall and harvesting stormwater to offset the loss of water supplies from reduced snowpack.⁶¹ In the East, the problem in most places may be too much rather than too little water, although, as noted, shortages of potable water are already a problem in the Southeast and are emerging even in the Northeast.⁶² The idea is the same either way: the less stormwater, the less pollution, and the more freshwater available for uses other than rinsing parking lots and transporting waste to lakes and rivers.

Successful stormwater control programs should contain the following elements:

- Advance planning and setting clear goals;
- Encouraging and facilitating broad government and community participation;
- Prioritizing pollution prevention over treatment of polluted runoff;
- Establishing and maintaining accountability of partners and citizens;
- Creating a stable funding source such as a stormwater utility;
- Tailoring strategies to local needs and problems;
- Including education, public participation, monitoring, and enforcement components;
- Evaluating and improving programs as they evolve;
- Recognizing and publicizing the quality-of-life benefits of parks, ponds, and clean streets.⁶³

term Adaptation to Climate Change (Nov. 21, 2009), available at http://www.unh.edu/erg/cstev/Presentations/ballestero_lid_practices.pdf (describing water management practices needed based on projected climactic shifts in rainfall, snow melt, and storm patterns). Information on the federal stormwater management program is available on EPA's website, http://cfpub.epa.gov/npdes/home.cfm?program_id=6 (last visited Feb 26, 2010).

61. NATURAL RESOURCES DEFENSE COUNCIL, A CLEAR BLUE FUTURE: HOW GREENING CALIFORNIA CITIES CAN ADDRESS WATER RESOURCES AND CLIMATE CHALLENGES IN THE 21ST CENTURY 4 (2009), available at <http://www.nrdc.org/water/lid/files/lid.pdf> (concluding that capturing rainwater at residential and commercial sites in Southern California and portions of the Bay Area could net more than 400,000 acre feet of water per year, enough to supply two-thirds of the water Los Angeles uses annually).

62. GLOBAL CLIMATE CHANGE, *supra* note 2, at 107 ("Short-term (one- to three-month) droughts are projected to occur as frequently as once each summer in the Catskill and Adirondack Mountains, and across the New England states.").

63. Natural Resources Defense Council, Urban Stormwater Solutions, <http://www.nrdc.org/water/pollution/nstorm.asp> (last visited Feb. 26, 2010).

Capturing and reusing stormwater runoff can greatly reduce the consumption of imported, potable water, as well as the energy usage and CO₂ emissions associated with moving water across great distances.⁶⁴ “The collection, distribution, and treatment of drinking water and wastewater nationwide consume tremendous amounts of energy and release approximately 116 billion pounds of CO₂ per year—as much global warming pollution each year as 10 million cars.”⁶⁵ Further:

[w]hen runoff is diverted and captured before it flows into surface waters, it can be used onsite either to replenish groundwater supplies through infiltration or for graywater uses, like landscape irrigation and toilet flushing. These techniques are known as low-impact development (LID), the central objective of which is to maintain individual sites’ pre-development hydrology. LID uses common sense and simple technology—strategically placed beds of native plants, rain barrels, “green roofs,” porous surfaces for parking lots and roads, and other measures—to retain rainfall onsite or to help rainfall soak into the ground, rather than polluting the nearest receiving water. In effect, LID mimics nature’s own filtration systems. In addition to reducing water and energy use, the result is less water pollution from contaminated runoff, less flooding, replenished water supplies, and often more natural-looking, aesthetically pleasing cityscapes.⁶⁶

III. RESTORING FLOODPLAINS AND WETLANDS

Floodplains and wetlands are dynamic ecosystems that provide a host of valuable ecosystem services including flood control, water quality maintenance, groundwater recharge, storm surge control, fish and wildlife habitat, recreation, and carbon sequestration.⁶⁷ The nation has lost over half of its wetlands since colonial times.⁶⁸ Development continues to take a toll on wetlands though restoration and mitigation efforts have resulted in a net

64. GLOBAL CLIMATE CHANGE, *supra* note 2, at 52.

65. NAT. RESOURCES DEF. COUNCIL, WATER EFFICIENCY SAVES ENERGY: REDUCING GLOBAL WARMING POLLUTION THROUGH WATER USE STRATEGIES 1 (2009), available at <http://www.nrdc.org/water/files/energywater.pdf>.

66. *Id.* at 2.

67. See generally WORLD RES. INST., MILLENNIUM ECOSYSTEM ASSESSMENT SYNTHESIS REPORT, ECOSYSTEMS AND HUMAN WELL-BEING: WETLANDS AND WATER (2005) (citation omitted), available at <http://www.maweb.org/documents/document.358.aspx.pdf> (providing an in-depth overview of various wetland services).

68. U.S. Environmental Protection Agency, Wetlands Status and Trends, <http://www.epa.gov/wetlands/vital/status.html> (last visited Feb. 26, 2010).

gain in wetlands acreage within recent years.⁶⁹ Development of wetlands and floodplains must take account of their unique ecological structure and dynamics to avoid unnecessary ecological and economic damage. Floodplains and wetlands are important components of climate adaptation and environmental “resilience because of their high compensatory potential to mitigate environmental change due to their capacity for water retention, food production, CO₂ sequestration, production of bio-fuels, and the diversity of habitats that they support.”⁷⁰ Agencies responsible for water resources, energy, transportation, and environmental management must elevate the protection of pristine sections of the floodplains and promote sustainable use and restoration of degraded floodplains on rivers, lakes, and coastal zones.

The current state of federal flood control policy creates perverse incentives for development and coordination. Not only does the construction of physical barriers like levees create incentives to develop floodplains, but federal bailouts and insurance programs are often called upon to foot the bill for unwise development decisions.⁷¹ Our whole approach to floodplains and other high-hazard areas, such as the coastal zones, must change in response to the increasing threats posed by climate change. Despite the expenditure of billions of dollars in “flood protection” measures—dams, levees, rip-rap, bulkheads, seawalls, etc.—flood damages have continued to increase. “Since 1934, the federal government has spent \$160 billion on flood control projects while floodplain users have suffered \$390 billion in losses nationwide.”⁷² The National Flood Insurance Program (NFIP) continues to encourage people to build in flood-prone areas and destroy wetlands and riparian habitat which serve as natural flood control features and buffers for rivers and streams.⁷³ “Recently, the [NFIP] faced insolvency following Rita and Katrina hurricanes, and has asked Congress

69. U.S. FISH & WILDLIFE SERV., WETLANDS STATUS AND TRENDS IN THE CONTERMINOUS UNITED STATES 1998 TO 2004, 17 (2006), available at http://www.fws.gov/wetlands/_documents/gSandT?NationalReports/StatusTrendsWetlandsConterminousUS1998to2004.pdf.

70. *Declaration on Sustainable Floodplain Management—change of perspective*, 8 *ECOHYDROLOGY & HYDROBIOLOGY* 105, 105 (2008), available at <http://versita.metapress.com/content/n128871m554071t9/fulltext.pdf>.

71. See, e.g., Lee Wilkins, *Living with the Flood: Human and Governmental Responses to Real and Symbolic Risk*, in *THE GREAT FLOOD OF 1993: CAUSES, IMPACTS, AND RESPONSES* 218, 218–43 (Stanley A. Changnon ed., 1996) (describing the factors contributing to the flood including levee systems and insurance coverage for properties in flood plains while also suggesting solutions for future government programs to mitigate flooding).

72. D. HEY, J. KOSTEL & D. MONTGOMERY, *CTR. ENVTL. SCIENCE, AN ECOLOGICAL SOLUTION TO THE FLOOD DAMAGE PROBLEM* 73, 74 (2009), available at http://www.wetlands-initiative.org/images/pdfs_pubs/FinalFloodForumProceedings.pdf.

73. See *id.* at 73 (explaining how U.S. flood losses continue increasing due to poor development choices).

to provide a \$23 billion loan to pay for flood claims stemming from the hurricanes.”⁷⁴ Flood insurance maps are largely obsolete because they are based on the one percent chance that a 100-year flood event will occur in any given year whereas more recent modeling shows that the risks are three to six times higher than that.⁷⁵ There is a reason that the private insurance market has largely pulled out of the coastal zones and is reevaluating risks in all flood-prone areas.⁷⁶ Yet our national policies and disaster agencies are not providing the public with accurate information about the hazards of continued development in these areas. We should not be playing Russian roulette with peoples’ lives and property. New buildings constructed in high-risk areas should not qualify for flood insurance.

New Federal Emergency Management Agency (FEMA) floodplain maps reflecting new areas of risk should be used when assessing insurance rates. Once the owner of a building in a flood-prone area has made one total loss claim to the NFIP, he or she should not be able to make another one, regardless of whether he chooses to rebuild in the flood plain or not. If a building permit is sought for an area deemed to be at high risk of a climate-related incident (flood, hurricane, etc.), the applicant should be provided with the best climate-impact information available at the time. Once a decision has been made to go ahead, the applicant should waive the ability to recoup public money in the event of a natural disaster.

The Presidential Climate Action Project has said:

The federal government has two principal responsibilities in adapting to global climate change. The first is to adjust to the impacts of climate change, actual or expected, in its own operations and in the public assets the government is entrusted to protect. The second is to help the rest of the nation adjust, through intelligent policies, programs and science.⁷⁷

74. ALLIANZ GROUP & WORLD WILDLIFE FOUND., CLIMATE CHANGE AND INSURANCE: AN AGENDA FOR ACTION IN THE UNITED STATES 29 (2006), available at <http://www.climateneeds.umd.edu/pdf/AllianzWWFreport.pdf>.

75. See Steve Meyers, *In the Danger Zone*, PRESS-REG., June 10, 2007, at A1 (discussing inadequacy of flood insurance maps and noting that in Alabama researchers have found flood risks to be six to nine times higher than FEMA predictions).

76. See generally JOHN B. STEPHENSON, U.S. GOV'T ACCOUNTABILITY OFFICE, CLIMATE CHANGE: FINANCIAL RISK TO FEDERAL AND PRIVATE INSURERS IN COMING DECADES ARE POTENTIALLY SIGNIFICANT (2007), available at <http://www.gao.gov/new.items/d07820t.pdf> (describing private insurers' incorporation of climate change impacts into risk management practices and federal insurers lack of climate change related risk assessment).

77. PRESIDENTIAL CLIMATE ACTION PROJECT, PRESIDENTIAL CLIMATE ACTION PLAN: SECURITY, OPPORTUNITY, STEWARDSHIP ch. 14, at 2 (2008), available at <http://www.climateactionproject.com/plan/> (follow “Adaptation”).

FEMA should reorient its mission to disaster prevention and emergency preparedness at the local level. It should practice “No Adverse Impact” management as recommended by the Association of State Floodplain Managers.⁷⁸ This means placing greater reliance on non-structural measures like zoning, rolling easements, greenways, and relocating buildings out of the floodplain.⁷⁹ The federal government should also create a Climate Change Adaptation Fund (funded at roughly a billion dollars a year) to provide block grants to states and municipalities to assist in their efforts to manage these risks. This could be funded from either a fee on greenhouse gas emissions or from the sale of allowances under a cap and trade program similar to provisions currently being considered by Congress in the Waxman-Markey and Kerry-Boxer bills.⁸⁰ The government could establish a Climate Adaptation Extension Service similar to the U.S. Department of Agriculture (USDA) extension service for farmers.⁸¹ There is also a need to improve predictive models of climate change impacts at the local and regional scale. It would be more cost effective for the federal government to provide this kind of institutional capacity than for individual States to tackle it.⁸²

IV. REDUCING THE IMPACTS ON WATER SUPPLIES AND AQUATIC RESOURCES FROM THERMOELECTRIC POWER PLANTS

According to the U.S. Geological Survey, “[p]roduction of electrical power results in one of the largest uses of water in the United States”⁸³

78. ASS’N OF FLOODPLAIN MANAGERS, NO ADVERSE IMPACT IN THE COASTAL ZONE 1–2 (Draft) (2006), available at http://www.floods.org/NoAdverseImpact/CNAI_Handbook_11-06.pdf.

79. *Id.* at 36–37, 46; see also Ballesterio et al., *supra* note 60 (describing necessary local level development, public works, and zoning projects for future patterns of increased and variable rain and snow fall).

80. See generally Posting of Holly Doremus & Alejandro Camacho to Waxman–Markey: Adaptation, LEGAL PLANET: ENVIRONMENTAL LAW AND POLICY, <http://legalplanet.wordpress.com/2009/04/07/waxman-markey-adaptation/> (Apr. 7, 2009) (explaining the adaptation provisions in the Waxman-Markey bill).

81. U.S. Department of Agriculture, National Institute of Food and Agriculture, <http://www.csrees.usda.gov/qlinks/extension.html> (last visited Feb. 8, 2010) (formerly known as Cooperative State Research, Education, and Extension Service (CREES)).

82. See, e.g., National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS), Climate Services Division, <http://www.weather.gov/os/csd/index.php> (last visited Feb. 9, 2010) (stating the Climate Services Division’s goal of ensuring the NWS is equipped to provide climate information). The National Oceanic and Atmospheric Administration (NOAA) has already established the Climate Services Division as part of the National Weather Service. *Id.* The mission of this new service is “[t]o ensure NWS is equipped to develop and deliver an end-to-end suite of climate variability and change products through strategic planning, user engagement, data stewardship, policy development, integration of research and assessments, partnerships, outreach, and training.” *Id.*

83. U.S. Geological Survey, Water Use: Thermoelectric power water use, <http://ga.water.usgs.gov/edu/wupt.html> (last visited Feb. 9, 2010).

In 2000, “[t]hermoelectric-power withdrawals accounted for 48 percent of total water use, 39 percent of total freshwater withdrawals for all categories, and 52 percent of fresh surface-water withdrawals.”⁸⁴ Cumulatively, these withdrawals serve to significantly reduce stream flows, lower groundwater tables, and divert water from other uses.⁸⁵

Water withdrawals can also cause enormous damage to aquatic ecosystems from the mortality caused by water intake structures. The EPA estimates that water intake structures kill 3.4 billion fish and shellfish each year.⁸⁶ The fish and shellfish are killed by “impingement” or “entrainment.”⁸⁷ Impingement occurs when aquatic organisms are trapped against the screens and grills of water intake structures.⁸⁸ Entrainment occurs when these organisms are drawn into the intake structures.⁸⁹ A closed-cycle cooling water intake system can minimize this problem.⁹⁰ Closed-cycle systems discharge heat through evaporation in cooling towers and recycle water within the power plant.⁹¹ The water required to do this is comparatively small since it is limited to the amount lost through the evaporative process.⁹² However, because of the expense associated with closed-cycle cooling, once-through systems are far more common.⁹³

Section 316(b) of the Clean Water Act authorizes the EPA to establish national performance standards for cooling water intake structures (CWIS).⁹⁴ The statutory standard is “best technology available for minimizing adverse environmental impact” or BTA.⁹⁵ The EPA used a phased approach to setting these standards. In Phase I, applicable to “new facilities,”⁹⁶ the agency essentially adopted closed-cycle or equivalent

84. *Id.*

85. Posting of Steven Weissman to Water for Power Plants: A major concern all of its own, LEGAL PLANET: ENVIRONMENTAL LAW AND POLICY, <http://legalplanet.wordpress.com/2009/07/23/water-for-power-plants-a-major-concern-all-of-its-own/> (July 23, 2009).

86. National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 Fed. Reg. at 41,586 (July 9, 2004) (to be codified at 40 C.F.R. pt. 9 & 122–25).

87. *Id.*

88. *Id.*

89. *Id.*

90. *Id.*

91. *Id.* at 41,601 (describing reduced mortality rates from use of closed-cycle recirculating cooling systems).

92. *Riverkeeper v. EPA*, 358 F.3d 174, 182 (2d Cir. 2004).

93. National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 Fed. Reg. 41,576 at 41,606.

94. *Id.* at 41,576.

95. 33 U.S.C. § 1326(b).

96. See 40 C.F.R. § 125.83 (2009) (defining a new facility as any facility constructed after the effective date of the regulation—January 17, 2002).

technologies as BTA.⁹⁷ This standard was upheld by the Second Circuit.⁹⁸ In Phase II, the EPA promulgated rules for existing facilities defined as any facility that is not a new facility and whose water-intake flow is more than 50 million gallons of water per day, at least 25% of which is used for cooling purposes.⁹⁹ Phase II covers over 500 facilities, representing approximately 53% of the country's electric-power generating capacity.¹⁰⁰ Unlike the Phase I rules, however, the Phase II rules did not mandate adoption of "closed-cycle cooling systems or equivalent reductions in impingement and entrainment"¹⁰¹ In rejecting closed-cycle cooling as a national performance standard for existing facilities, the EPA concluded that in some cases the costs outweighed the benefits, as measured by the market value of the organisms killed.¹⁰² These rules were challenged by both environmental and industry groups. In an opinion written by then-Second Circuit judge, now-Supreme Court Justice Sonia Sotomayor, the court rejected the EPA's interpretation that it had the authority to conduct a cost-benefit analysis in setting BTA and overturned the rules on that ground.¹⁰³ However, the Supreme Court granted certiorari and reversed, holding that the language of Section 316(b) was ambiguous and that the EPA's interpretation was permissible.¹⁰⁴ Importantly, the Court did not say that the EPA *must* conduct a cost-benefit analysis, only that it could take costs and benefits into account in deciding whether to allow a "variance" from technologies that would "minimize" environmental harm.¹⁰⁵ The EPA is now in the process of developing revised Phase II regulations.¹⁰⁶ Hopefully, the EPA will take into account the fact that closed-cycle cooling

97. 40 C.F.R. § 125.94 (2009).

98. *See Riverkeeper*, 358 F.3d at 187 (suggesting that the Clean Water Act appears requires the "best technology available").

99. National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 Fed. Reg. at 41,590.

100. *Entergy Corp. v. Riverkeeper, Inc.*, 129 S.Ct. 1498, 1504 (2009).

101. *Id.* at 1500.

102. *See* National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 Fed. Reg. at 41,666 (discussing the social costs exceeding the total use benefits, but in an equation without the estimated value of non-use benefits).

103. *Riverkeeper v. EPA*, 475 F.3d 83, 104–05 (2d Cir. 2007), *rev'd Entergy Corp.*, 129 S.Ct. at 1510.

104. *Entergy Corp.*, 129 S. Ct. at 1510.

105. *Id.* at 1508–09 ("[I]t was well within the bounds of reasonable interpretation for the EPA to conclude that cost-benefit analysis is not categorically forbidden.").

106. *See* Agency Information Collection Activities; Proposed Collection; Comment Request; Information collection Request for Cooling Water Intake Structures New Facility Final Rule (Renewal), 73 Fed. Reg. 16,669, 16,669–700 (Mar. 28, 2008) (requesting information from interested parties in renewing Phase II/cooling water intake rule).

not only reduces mortality from intake structures but that it reduces the overall stress on aquatic ecosystems from massive water withdrawals for thermoelectric power plants; and that it will exercise its discretion to mandate closed-cycle cooling for all power plants except in the most unusual circumstances where the costs are “wholly disproportionate” to the ecological (non-monetized) benefits.¹⁰⁷

Pending a new rulemaking, States are to use “best professional judgment” (BPJ) in setting BTA for cooling water intakes.¹⁰⁸ Also, because States are free to set technology-based and water quality-based standards that are stricter than what the EPA might require, there is no legal obstacle to the States moving forward now to require closed-cycle at thermoelectric plants. This can be done in the context of the regular five-year period for renewal of National Pollution Discharge Elimination System (NPDES) permits. Of course, there are bound to be significant political obstacles to imposing such costs on existing facilities, and these costs would no doubt be passed along to ratepayers. To soften the blow, States could consider providing tax breaks or low-interest loans for retrofitting older plants. In some cases, the best course may be to replace an aging steam plant, especially one that is fossil-fueled, with a combination of enhanced efficiency (demand-side management) and alternative energy sources.

V. OTHER APPROACHES

Time and space do not permit an examination of many other techniques that will be necessary to cope with the effects of climate disruption. These include: better pricing of water to reduce waste and promote more efficient uses including re-use and recycling; use of environmental assessment laws like NEPA to disclose the impacts of climate change on water resources, consider alternatives to reduce greenhouse gas emissions, and conserve carbon sinks such as wetlands, riparian zones, and forests; local land use controls to reduce highways, sprawl, and impervious surfaces; policies and

107. *Entergy Corp.*, 129 S. Ct. at 1515 (Breyer, J., concurring in part, dissenting in part). Justice Breyer commented that EPA had previously used this “wholly disproportionate” test, and chided the agency for not explaining why it was abandoning it in favor of the looser “significantly greater” cost test, yet the “[EPA] has not explained why the traditional ‘wholly disproportionate’ standard cannot do the job now, when the EPA has used that standard (for existing facilities and otherwise) with apparent success in the past.”*Id.*; see also *In re Pub. Serv. Co. of New Hampshire*, 1 E.A.D. 332, 340 (1977) (also using the “wholly disproportionate” test to describe the balancing of environmental harm and economic costs).

108. 40 C.F.R. § 125.90(b) (2009) (“Existing facilities that are not subject to requirements under this or another subpart of this part must meet requirements under section 316(b) of the CWA determined by the Director on a case-by-case, best professional judgment (BPJ) basis.”).

investments that promote green infrastructure; and more ecologically sound methods of wastewater treatment.

CONCLUSION

The title of the Scientific Expert Group report accompanying the Fourth Assessment is *Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable*.¹⁰⁹ This title captures the moment about as well as anything. We have dug ourselves into a very deep hole. The first thing we need to do is stop digging. At the same time, we have to build ladders to climb out and adapt to a climate-altered world. As President Obama's Chief of Staff, Rahm Emanuel, has said, no crisis should go to waste.¹¹⁰ Our collective task is to turn crisis into opportunity. The things we need to do to mitigate and adapt to climate change are the things we should have been doing all along to make more efficient use of the planet's limited resources and to show greater respect for the natural systems that have allowed life on earth to flourish for millenia.

109. Scientific Expert Group on Climate Change, *Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable* (2007), available at <http://www.sigmaxi.org/prgrams/unseg/index.shtml> (follow "Confronting Climate Change").

110. Editorial, *A 40-Year Wish List*, WALL ST. J., Jan. 28, 2009, at A14, available at <http://online.wsj.com/article/SB123310466514522309.html>.

