

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

Patrick Parenteau

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’s, 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; sea levels are rising faster than predicted³; the ocean is slowly turning acid⁴; tropical storms are intensifying⁵; saltwater is contaminating coastal aquifers and degrading estuaries; lake levels are dropping; runoff is increasing⁶; flood peaks are growing⁷; droughts are intensifying⁸; wildfires are spreading⁹; pests and invasive species are

* Please ask for biographical information in initial email.

1. Intergovernmental Panel on Climate Change, CLIMATE CHANGE 2007: SYNTHESIS REPORT 30 (Core Writing Team, R.K. Pachauri & A. Reisinger eds., 2007), available at http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm (hereinafter *IPCC 2007*) (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., Cambridge Univ. Press, 2009) (citing among the key findings, “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.”).

3. Lisa Mastny, *Melting of Earth's Ice Cover Reaches New High*, WORLDWATCH INSTITUTE (Mar. 6, 2000), available at <http://www.worldwatch.org/node/1673>.

4. Professor James Lovelock, Address at the Royal Society, Climate Change On the Living Earth (Oct. 29, 2007), available at http://royalsociety.org/General_WF.aspx?pageid=4294968606&terms=ocean+acid.

5. See K. Emanuel, *Increasing Destructiveness of Tropical Cyclones Over the Past 30 Years*, 436 NATURE 686 (2005) (concluding that tropical storms have been intensifying over the past 30 years), available at <ftp://texmex.mit.edu/pub/emanuel/PAPERS/NATURE03906.pdf>.

6. See S. Zektser, H. A. Loaicigal, & J. T. Wolf, *Environmental Impacts of Groundwater Overdraft: Selected Case Studies in the Southwestern United States*, 47 ENVTL. GEOLOGY 396 (2005) (describing these effects: river runoff, dropping lake levels, and changes in coastal aquifers), available at <http://www.springerlink.com/content/5n3d9wggktd2waq/>.

7. See Huang-jia Huang et. al., *Effect of Growing Watershed Imperviousness on Hydrograph Parameters and Peak Discharge*, 22 HYDROLOGICAL PROCESSES 2075 (2007) (describing growing flood peaks amid other effects).

8. 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

expanding; diseases are moving into population centers; ecosystems are shifting poleward and upward; migratory species patterns are changing¹⁰; coldwater habitat is shrinking¹¹; more deadly heatwaves are expected¹². And none of that takes into account the potential for “abrupt climate change” which could unleash truly catastrophic, Hollywood disaster movie scenarios.¹³

The math is sobering. Average global temperatures have increased by .8° C (1.4° F) within the past fifty years and are the highest they have been in over 10,000 years.¹⁴ Atmospheric concentrations of CO₂, which have gone from 280 PPM pre-industrial revolution to approximately 387 PPM today, are the highest they have been in over 650,000 years of earth’s geologic history.¹⁵ 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.¹⁶ Worse, due to the longevity of CO₂ in the atmosphere, the full effect of the “radiative forcing” has not been felt as yet and average temperatures are expected to rise another .5 to 2.8° C under the most optimistic scenarios for limiting GHG.¹⁷ Further, the changes that are underway are essentially irreversible. As a recent report of

(describing drought conditions resulting from anthropocentric climate influences).

9. See Lester Brown, *Inferno on Earth: Wildfires Spreading as Temperatures Rise*, GRIST (Nov. 19, 2009) (describing connection between the increase of wildfires and rising temperature), available at <http://www.grist.org/article/inferno-on-earth-wildfires-spreading-as-temperatures-rise/>.

10. Steven W. Running & L. Scott Mills, *Terrestrial Ecosystem Adaptation*, RES. FOR THE FUTURE 15–16 (2009), available at <http://www.rff.org/RFF/Documents/RFF-Rpt-Adaptation-RunningMills.pdf>.

11. See Steven Kinsella, *The Impacts of Global Warming on Trout in the Interior West*, (NRDC 2008) (describing global warming’s impact on trout species’ habitat in the American West), available at <http://www.nrdc.org/globalwarming/trout/trout.pdf>.

12. See Scripps Institute of Oceanography, *Deadly Heat Waves are Becoming More Frequent in California* (Aug. 25, 2009), available at <http://scrippsnews.ucsd.edu/Releases/?releaseID=1018>.

13. See Wallace S. Broecker & Robert Kunzig, *FIXING CLIMATE* (2009) (explaining the 2004 movie “Day After Tomorrow” depicts the earth plunging into an ice age over a weekend, an obviously fictional account of the effects of “abrupt climate change,” but one that is loosely based on the serious work of noted climatologist Wally Broecker who has warned of the dangers of the potential slowing or complete shutdown of the thermo-haline circulation (the “ocean conveyor belt”) from massive infusion of freshwater into the North Atlantic).

14. EPA, Proposed Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 FED. REG. 18885,18896 (Apr. 24, 2009).

15. *Id.* at 18895–96.

16. IPCC 2007, *supra* note 1, at 3.

17. D. P. Van Vuuren et al., *Temperature Increase of 21st Century Mitigation Scenarios*, 105 PROC. NAT’L ACAD. SCI. U.S. 15258, 15258 (Oct. 7, 2008) (concluding, “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.”), available at <http://www.pnas.org/content/105/40/15258.full.pdf+html>.

the National Oceanic and Atmospheric Administration 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”¹⁸ 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.”

Barring a political miracle, the goal recently expressed by the G-7 nations of holding the average global temperature to 2° C in order to avoid “dangerous anthropogenic interference with the climate” is probably unattainable given the scale of what needs to be done to “de-carbonize” the global economy over the next few decades, and the daunting political challenges of reconciling the economic disparities between developed and developing nations as demonstrated by the inability to forge a binding new treaty at the recently concluded COP15 meeting in Copenhagen.¹⁹ Suffice 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.²⁰

In short, the window of opportunity to prevent serious impacts from climate disruption has closed. The choices now, as John Holdren, President

18. Susan Solomon et al., *Irreversible Climate Change Due to Carbon Dioxide Emissions*, 106 PROC. NAT'L ACAD. SCI. U.S. 1704, 1704 (Jan. 28, 2009), available at <http://www.pnas.org/content/106/6/1704.full.pdf+html?sid=819c1042-fab1-4dce-88c7-e2c118f0f904>

19. President Obama was instrumental in salvaging a last minute deal among the US, China, India and Brazil recognizing that “deep 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.” Copenhagen Accord, Decision -/CP.15; available at http://unfccc.int/files/meetings/cop_15/application/pdf/cop15_cph_auv.pdf The deal calls for these emission cuts by 2020:

_ U.S., a 17 percent reduction from 2005 levels (or 3-4 percent from 1990 levels).

_ China, a cut of 40 to 45 percent below “business as usual,” that is, judged against 2005 figures for energy used versus economic output.

_ India, 20 to 25 percent cut from 2005 levels

_ European Union, 20 percent cut from 1990, and possibly 30 percent.

The Accord also commits nations to develop protocols to monitor, report and verify emissions and calls upon wealthy nations to raise \$100 billion by 2020 to aid poorer nations in coping with the effects of climate change. However, the Accord 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. See Andrew C. Revkin and John M. Broder, “A Grudging Accord in Copenhagen,” NYT December 19, 2009.

20. Text of the convention is available at: <http://unfccc.int/resource/docs/convkp/conveng.pdf>

Obama's Science Advisor, puts it are to "mitigate, adapt or suffer."²¹ 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" that many scientists are warning about.²² We face a double bind: at the same time that we must step up efforts to mitigate climate change through rapid and steep GHG 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) of "climate refugees" that are projected over the coming years.²³

Water resources are in the center of the climate change bulls-eye.²⁴ 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. As reported by the New York Times, Douglas County was "hit by 21 inches of rain in a 24-hour period from Sunday to Monday, knocking out the drinking water supply to most residents, and forcing others to boil their water."²⁵ As much as 15 to 20 inches of rain pounded counties around Atlanta for more than 72 hours.²⁶ Nine people

21. 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>.

22. See James Hansen, *Tipping Point: Perspective of a Climatologist*, STATE OF THE WILD 6, 8 (2008-09) (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), *available at* http://www.columbia.edu/~jeh1/2008/StateOfWild_20080428.pdf

23. Cf. António Guterres, UN High Commissioner for Refugees, *Climate Change, Natural Disasters and Human Displacement: A UNHCR Perspective* 3 (Aug. 2009) (noting that there were an estimated 20 million climate refugees in 2008 alone), *available at* http://www.globalmigrationgroup.org/pdf/UNHCR_Policy_Paper_Climate_Change.pdf.

24. IPCC, *Climate Change 2007: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change 175 (Parry, Martin L., Canziani, Osvaldo F., Palutikof, Jean P., van der Linden, Paul J., and Hanson, Clair E., eds., 2007) (explaining "All regions of the world show an overall net negative impact of climate change on water resources and freshwater ecosystems. Areas in which runoff is projected to decline are likely to face a reduction in the value of the services provided by water resources. The beneficial impacts of increased annual runoff in other areas are likely to be tempered in some areas by negative effects of increased precipitation variability and seasonal runoff shifts on water supply, water quality and flood risks."), *available at* <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter3.pdf>.

25. Robbie Brown, *Georgians Grappling with Flood Damage*, N.Y. TIMES, Sept. 23, 2009, at A23.

26. *Id.*

died.²⁷ A state climatologist called it “the worst [flooding] in 100 years in some parts of Atlanta.”²⁸ 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, “For 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.”²⁹ In the Atlanta metropolitan area, which has more than four million people, worst-case analyses showed that the city’s main source of water, Lake Lanier, could be drained dry in 90 to 121 days.³⁰ In North Carolina, Gov. Michael F. Easley asked residents to stop using water for any purpose “not essential to public health and safety.”³¹

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.³² As noted climatologist Stephen Schneider has said, “Global warming will intensify drought, and it will intensify floods.”³³ 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 Magna Carta to the Justinian Code, is recognized in the United States³⁴ but apparently has not been fully incorporated into Canadian jurisprudence.³⁵ In its simplest formulation the PTD provides that states hold the waters of

27. *Id.*

28. Marcus K. Garner and Mike Morris, *Dry Rush Hour; 9 Flooding Records Set*, ATLANTA J. CONST., (Sept. 23, 2009).

29. Brenda Goodman, *Drought-Stricken South Facing Tough Choices* (Oct. 16, 2007).

30. *Id.*

31. *Id.*

32. Cf. Gabriele C. Hegerl et. al., *Detectability of Anthropogenic Changes in Annual Temperature and Precipitation Extremes*, 17 J. CLIMATE, Vol. 17 Issue 19, 3683–3700 (2004).

33. Doug Struck, *Warming Will Exacerbate Global Water Conflicts*, WASH. POST, Aug. 20, 2007.

34. Cf. *Illinois Cent. R.R. v. Illinois*, 146 U.S. 387 (1892).

35. Cf. *Green v. R.*, 34 D. L. R.3d 20 Ont. H. C. (1972); Ralph Pentland, *Public Trust Doctrine -Potential in Canadian Water and Environmental Management*, (June 2009), available at <http://www.waterdsm.org/publication/261>

navigable streams and their nonnavigable tributaries, submerged lands, and fishery and wildlife resources in trust for the benefit of all people. In practice, however, the PTD is not a unitary doctrine; rather it is a product of the common law heritage of the individual states. Thus there is not one PTD but perhaps as many as 50 doctrines. Professor Robin Kundis Craig has surveyed all the states and published a handy compilation divided into Eastern and Western states.³⁶ Her survey notes some major differences among the states in the scope, effect and enforceability of the PTD as applied.³⁷ 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.³⁸ Professor Craig has also written an article applying the PTD to climate adaptation.³⁹ 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 means of (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.⁴⁰

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

36. See Robin K. Craig, A Quick and Dirty Guide to the Eastern Public Trust Doctrines: Basic Issues, Classifications of States, and State Summaries (draft, 2007) (elaborating public trust doctrine cases and academic works relating to Eastern states), available at http://works.bepress.com/robin_craig/1; Robin K. Craig, A Comparative Guide to the Western States' Public Trust Doctrine: Public Values, Private Rights, and the Evolution Toward an Environmental Public Trust (2009) (elaborating public trust doctrine cases and works relating to Western states), available at http://works.bepress.com/robin_craig/5.

37. Craig, Eastern & Western articles, supra note 44.

38. *Id.*

39. Robin K. Craig, *Adapting to Climate Change: the Potential Role of State Public Trust Doctrines*, 34 VT. L. REV. at 2 (forthcoming spring 2010), available at <http://ssrn.com/abstract=1431663>.

40. *Id.*

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.⁴¹

Whether this expansive view of the PTD will be adopted by the courts or legislatures is an open question. A great deal will depend 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.⁴² Traditionally, stormwater has been regarded as a source of pollution to be regulated at the point of discharge.⁴³ That will have to change as the sheer volume and costs of trying to capture and treat, through best management practices and other techniques, ever-increasing amounts of stormwater overwhelm municipal and private systems.⁴⁴ In fact, in many parts of the country, particularly the arid West, communities

41. Mary C. Wood, *Nature's Trust: Reclaiming the Environmental Discourse*, 25 VA. ENVTL. L. J. 243, 252 (2007).

42. See generally, UNITED STATES GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES, 41-52 (2008)(hereafter, "Global Climate Change"); available at: <http://www.globalchange.gov/images/cir/pdf/water.pdf>

43. Cf. Section 402 (p) of The Clean Water Act, 33 U.S.C. § 1342 (p). Information on the federal stormwater management program is available on EPA's website at: http://cfpub.epa.gov/npdes/home.cfm?program_id=6

44. See for example, Thomas P. Ballester, Robert Roseen and Julia Barbu, "LID Practices as a Means of Resilience and Short Term Adaptation to Climate Change," The 2009 New Hampshire Joint Water and Watershed Conference (November, 2009); available at: http://www.unh.edu/erg/cstev/Presentations/ballester_lid_practices.pdf

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.⁴⁵ 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.⁴⁶ 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:

- (1) Advance planning and setting clear goals;
- (2) Encouraging and facilitating broad government and community participation;
- (3) Prioritizing pollution prevention over treatment of polluted runoff;
- (4) Establishing and maintaining accountability of partners and citizens;
- (5) Creating a stable funding source such as a stormwater utility;
- (6) Tailoring strategies to local needs and problems;
- (7) Including education, public participation, monitoring, and enforcement components;
- (8) Evaluating and improving programs as they evolve;
- (9) Recognizing and publicizing the quality-of-life benefits of parks, ponds, and clean streets.⁴⁷

Capturing and reusing stormwater runoff can greatly reduce the consumption of imported, potable water, as well as the energy usage and

45. Natural Resource Defense Council, *A CLEAR BLUE FUTURE: HOW GREENING CALIFORNIA CITIES CAN ADDRESS WATER RESOURCES AND CLIMATE CHALLENGES IN THE 21ST CENTURY*, 20 (2009) (studying urbanized regions of Southern California and portions of the Bay Area concluded that capturing rainwater at residential and commercial sites could net more than 400,000 acre-feet of water a year, enough to supply two-thirds of the water used annually by the city of Los Angeles), *available at* <http://www.nrdc.org/water/pollution/storm/stoinx.asp>.

46. Global Climate Change, at 107 (2008) ("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."), *available at* <http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts>.

47. Natural Resource Defense Council, *Water Efficiency Saves Energy: Reducing Global Warming Pollution Through Water Use Strategies*, 2 (2009), *available at* <http://www.nrdc.org/water/energywater.asp>.

CO₂ emissions associated with moving water across great distances.⁴⁸ The collection, distribution, and treatment of drinking water and wastewater nationwide consume tremendous amounts of energy and release approximately 116 billion pounds of carbon dioxide (CO₂) per year--as much global warming pollution each year as 10 million cars.⁴⁹ 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.⁵⁰

III. RESTORING FLOODPLAINS AND WETLANDS

Floodplains and wetlands are dynamic ecosystems, integral parts of river basins with a high potential for biological productivity, biodiversity, flood mitigation, groundwater recharge, river purification and regulation of exchanges of nutrients between land and water, and other ecosystem services, all maintained by the pulse-regulated hydrology of running waters.⁵¹ Floodplains and wetlands are threatened by increasing population and improper management. Development of floodplains and wetlands without consideration of the specifics of their ecological structure and dynamics thus diminishes biodiversity, reduces benefits to society related to water quality, cultural aesthetic values and - in consequence - causes

48. Global Climate Change, at 52.

49. *Id.* at 1.

50. *Id.* at 2.

51. United Nations Educational, Scientific and Cultural Organization, *Sustainable Floodplain Management: Declaration Changes Perspective* (May 26, 2009), available at <http://www.preventionweb.net/english/professional/news/v.php?id=9596>.

economic losses.⁵²

Floodplains and wetlands are important components of climate adaptation and 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.⁵³ Policies by national and state institutions 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.⁵⁴ 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.⁵⁵ 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.⁵⁶ Recently, the NFIP faced insolvency following Rita and Katrina hurricanes, and has asked Congress to provide a \$23 billion loan to pay for flood claims stemming from the hurricanes.⁵⁷ Flood insurance maps are largely obsolete because they are based on the 1% chance that a hundred 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.⁵⁸ There is a reason that the private insurance

52. *Id.*

53. *Id.*

54. See generally, Stanley A. Changnon: The Great Flood of 1993: Causes, Impacts, and Responses, Westview Press, 1996

55. D. Hey, J. Kostel & D. Montgomery, *An Ecological Solution to the Flood Damage Problem*, *CTR. ENVTL. SCI.* 73, 755 (2009), available at http://www.wetlands-initiative.org/images/pdfs_pubs/FinalFloodForumProceedings.pdf.

56. *Id.*

57. Allianz & World Wildlife Foundation, *CLIMATE CHANGE AND INSURANCE: AN AGENDA FOR ACTION IN THE UNITED STATES*, 29 (2006) available at <http://www.climateneeds.umd.edu/pdf/AllianzWWFreport.pdf>.

58. See Institute for Business and Home Safety, *HURRICANE IKE, NATURE'S FORCE VS.*

market has largely pulled out of the coastal zones and is re-evaluating risks in all flood-prone areas.⁵⁹ 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 built in high risk areas should not qualify for flood insurance.

New 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 will 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 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. FEMA should re-orient 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.⁶⁰ This means placing greater reliance on non-structural measures like zoning, rolling easements, greenways and relocating buildings out of the floodplain. 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 GHG 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.⁶¹ The government could establish

STRUCTURAL STRENGTH, 55 (2009) (comparing state and municipal requirements with recent modeling studies), *available at* http://www.eenews.net/public/25/12353/features/documents/2009/09/15/document_cw_01.pdf.

59. See generally, Government Accountability Office, "Climate Change: Financial Risk to Public and Private Insurers in Coming decades are Potentially Significant," GAO-07-820T (2007)

60. Association of Floodplain Manager, NO ADVERSE IMPACT IN THE COASTAL ZONE 1, 5 (Draft, Nov. 2006), *available at* http://www.floods.org/NoAdverseImpact/CNAI_Handbook_11-06.pdf.

61. See Alejandro Camacho, Center for Progressive Reform, *Waxman-Markey: Adaptation*, LEGAL PLANET (Apr. 7, 2009) (explaining the adaptation provisions in the bills)

a Climate Adaptation Extension Service similar to the USDA extension service for farmers. There is also a need to improve predictive models of climate change impacts at local and regional scales. It would be more cost effective for the federal government to provide this kind of institutional capacity than for individual states to tackle it.⁶²

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

Production of electricity results in one of the largest uses of water in the United States.⁶³ Water for thermoelectric power is used in generating electricity with steam-driven turbine generators. In 2000, about 195,000 million gallons of water each day (Mgal/d) were used to produce electricity.⁶⁴ Thermoelectric-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.⁶⁵ In 2000, withdrawals were an estimated 137,000 million gallons per day or 153,000 thousand acre-feet per year.⁶⁶ While almost all of this water usage is “non-consumptive” this enormous source of demand reduces stream flows, lowers groundwater tables, and diverts water from other uses.

Water withdrawals can also cause enormous damage to aquatic ecosystems from the mortality caused by water intake structures. EPA estimates that water intake structures kill 3.4 billion fish and shellfish each year.⁶⁷ The fish and shellfish are killed by “impingement” or “entrainment.”⁶⁸ Impingement occurs when aquatic organisms are trapped against the screens and grills of water intake structures. Entrainment occurs when these organisms are drawn into the intake structures. A closed-cycle cooling water intake system can minimize this problem. Closed-cycle

<http://legalplanet.wordpress.com/2009/04/07/waxman-markey-adaptation/>

62. The National Oceanic and Atmospheric Administration (NOAA) has already established the Climate Services Division as part of the National Weather Service. The mission of this new service is to “To ensure [the National Weather Service] 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.” Information available at <http://www.weather.gov/os/csd/index.php>

63. United States Geological Survey, Thermoelectric-power Water Use (May 2009), *available at* <http://ga.water.usgs.gov/edu/wupt.html>.

64. *Id.*

65. *Id.*

66. *Id.*

67. *See* National Pollutant Discharge Elimination System—Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 FED. REG. 41576-01, 41587 (July 9, 2009).

68. *Id.*

systems discharge heat through evaporation in cooling towers and recycle water within the power plant. The water required to do this is comparatively small since it is limited to the amount lost through the evaporative process. However, because of the expense associated with closed-cycle cooling, once-through systems are far more common.

Section 316(b) of the Clean Water Act authorizes EPA to establish national performance standards for cooling water intake structures (CWIS). 33 U.S.C. §1326 (b). The statutory standard is “best technology available to minimize environmental impact” or BTA.⁶⁹ EPA used a phased approach to setting these standards. In Phase I, applicable to “new facilities,”⁷⁰ the agency essentially adopted closed cycle or equivalent technologies as BTA.⁷¹ This standard was upheld by the Second Circuit.⁷² In Phase II, 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 percent of which is used for cooling purposes.⁷³ Over 500 facilities, accounting for approximately 53 percent of the Nation's electric-power generating capacity, fall within Phase II's ambit.⁷⁴ In its Phase II rules, however, the EPA expressly declined to mandate adoption of closed-cycle cooling systems or equivalent reductions in impingement and entrainment, as it had done for new facilities subject to the Phase I rules. In rejecting closed cycle cooling as a national performance standard for existing facilities EPA concluded that in some cases the costs outweighed the benefits as measured by the market value of the organisms killed.⁷⁵ These rules were challenged by both environmental and industry groups and in an opinion written by then Second Circuit judge, now Supreme Court Justice Sonia Sotomayor, the court rejected EPA's interpretation that it had the authority to conduct a cost-benefit analysis in setting BTA and overturned the rules on that ground.⁷⁶ However, the Supreme Court granted

69. *Id.*

70. *See* 40 CFR 125.83 (Jan. 7, 2002) (defining a new facility is convoluted but basically refers to any facility constructed after the effective date of the regulation).

71. *See* 40 CFR §125.84, 125.85.

72. *See Riverkeeper v. EPA*, 358 F.3d 174, 187 (2d Cir. (2004)) (holding that the CWA appears to require BTA).

73. *See* 69 FED. REG. 41576-01 (July 9, 2004) (defining Phase II facilities).

74. *See Id.* (describing the point sources to which Phase II applies).

75. 69 FED. REG. at 41666 (interestingly, when “non-market” values were considered the benefits of closed cycle exceeded costs by almost 10 to 1, and the EPA acknowledged that its failure to monetize the other 98.2 percent of affected species “could result in serious misallocation of resources” because its comparison of complete costs and incomplete benefits does not provide an accurate picture of net benefits to society).

76. *Riverkeeper v. EPA*, 475 F.3d 83, 105 (2d Cir. 2007) (reversed by *Entergy Corp. v. Riverkeeper*, 129 S.Ct. 1498).

certiorari and reversed, holding that the language of section 316(b) was ambiguous and that EPA's interpretation was permissible.⁷⁷ Importantly, the Court did not say that 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.⁷⁸ EPA is now in the process of developing revised Phase II regulations. Hopefully, EPA will take into account the fact that closed cycle cooling not only reduces mortality from intake structures but that it reduces the overall stress on aquatic ecosystems from massive water withdrawals for thermo-electric powerplants; and that it will exercise its discretion to mandate close cycle cooling for all power plants except in the most unusual circumstances where the costs are "wholly disproportionate" to the ecological (non-monetized) benefits.⁷⁹

Pending a new rulemaking, states are to use "best professional judgment" (BPJ) in setting BTA for cooling water intakes.⁸⁰ Also, because states are free to set technology based and water quality-based standards that are stricter than what EPA might require, there is no legal obstacle to the states moving forward now to require closed cycle at thermo-electric plants. This can be done in the context of the regular five year period for renewal of 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

77. *Entergy v Riverkeeper*, 129 S. Ct. 1498, 1501 (2009).

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

79. *Entergy*, 129 S. Ct. at 1515 (Breyer, J, concurrence/dissent) (noting 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."). *See also, In re Public Service Co. of New Hampshire*, 1E.A.D. 332, 340 (1977) (also using the "wholly disproportionate" phrase to describe the balancing of environmental harm and economic costs).

80. 40 CFR 125.90(b) ("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.")

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 and consider alternatives to reduce GHG 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 investments that promote green infrastructure; and more ecologically sound methods of wastewater treatment.

CONCLUSION

The title of the IPCC's Scientific Expert Group report accompanying the Fourth Assessment is "Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable." That 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 has said no crisis should go to waste. 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 the past 10,000 years.