Heat Waves, Global Warming, and Mitigation

*Ann E. Carlson**

* Professor of Law, UCLA School of Law and Faculty Director, UCLA Environmental Law Center. I thank Dan Farber and Jody Freeman for extremely valuable comments and Dhananjay Manthripragada and Louis Sloniker for superb research assistance. A slightly modified version of this article was published in Issues in Legal Scholarship, Catastrophic Risks: Prevention, Compensation and Recovery (2007), Article 7, http://www.bepress.com/ils/iss10/art7/.

I.
INTRODUCTION

Global climate change is almost certain to increase the frequency and intensity of heat waves. Over the last fifty years we have seen an increase in heat wave events, an increase scientists believe is the result, at least in part, of human activity.[1] The recently released Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC) concludes that heat waves will "very likely" increase over most land areas over the course of this century.[2] Conservative modeling estimates predict that these increases, absent significant reductions in carbon emissions, will result in a 70% increase in heat-wave deaths in the U.S. over the next forty years.[3]

Heat waves differ in important respects from natural disasters like hurricanes or earthquakes. Our collective memory about these events fades quickly once temperatures return to normal. Few people seem to remember, for example, that the Chicago heat wave of 1995 killed more than 700 people,[4] or that more than 52,000 Europeans perished in the extreme heat of the summer of 2003 – including more than 14,800 in France alone.[5] Even

1. *See* Intergovernmental Panel on Climate Change [hereinafter IPCC], *Climate Change 2007: The Physical Science Basis, Summary for Policymakers, Contribution of Working Group I to the Fourth Assessment on Intergovernmental Panel on Climate Change* 8 (Feb. 2007).

2. *Id.*

3. *See* Laurence S. Kalkstein & J. Scott Greene, *An Evaluation of Climate/Mortality Relationships in Large U.S. Cities and the Possible Impacts of a Climate Change*, 105 ENVTL. HEALTH PERSP. 84, 90 (1997).

4. For a definitive and fascinating account of the Chicago heat wave of 1995, see ERIC KLINENBERG, HEATWAVE: A SOCIAL AUTOPSY OF DISASTER IN CHICAGO (Univ. of Chicago Press 2002).

5. *See* Tom Kosatsky, The 2003 European Heat Waves, 10 EUROSURVEILLANCE 148 (2005), *available at* http://www.eurosurveillance.org/em/v10n07/1007-222.asp (revising the initial estimates of 22,000 dead upwards by at least fifty percent); Janet Larsen, Setting the Record Straight: More than 52,000 Europeans Died from Heat in Summer 2003, Earth Policy Institute, July 28, 2006, *available at* http://www.earth-policy.org/Updates/2006/Update56.htm; Laurent Toulemon & Magali Barbieri, The Mortality Impact of the August 2003 Heat Wave in France 3 (Mar. 30, 2006) (unpublished manuscript, *available at* http://paa2006.princeton.edu/download.aspx?submissionId=60411) (reviewing estimates of death totals of between 45,000 and 50,000 deaths).

the 2006 deadly heat wave in California, in which at least 140 and as many as 466 people died, has faded quickly from public consciousness.[6] Furthermore, a prolonged U.S. heat wave during the summer of 1980, during which researchers estimate that between 1,500 and 10,000 people perished, has been long forgotten.[7]

Increased heat waves from climate change are not, of course, the only catastrophic effects expected from global warming. Some of the most dramatic effects may require large structural and political changes. For example, massive sea level rise will require infrastructure investments to protect vulnerable shorelines, and prolonged drought may cause political upheaval and unrest in areas of the world where water is already scarce. The good news about increased heat waves, by contrast, is that we already posses the know-how to respond to the corresponding increase in health risk. Heat waves are not a new phenomenon, and some jurisdictions have made impressive strides in reducing heat-wave deaths. But many jurisdictions across the U.S. are ill-prepared to cope.[8] If Hurricane Katrina and its aftermath have taught us anything, it is that we need local, contextualized preparation (taking into account cultural, social and economic realities) to minimize catastrophe.

I explore the phenomenon of heat waves in this article for two reasons.[9] First, heat waves already pose a large health threat to our most vulnerable populations and, though we possess the means and know-how to prevent many heat-wave deaths, many U.S. jurisdictions are unprepared to cope. Second, the future looks even worse. As the IPCC Fourth Assessment warns, global climate change will very likely increase the frequency and intensity of extreme heat events over the course of the 21st century.[10] Unless we engage in efforts to mitigate the worst effects of extreme heat, heat death tolls will dwarf current annual rates.

---

6. *The Nation / Daily Briefing*, BOSTON GLOBE, July 12, 2007.

7. Neal Lott & Tom Ross, *Tracking and Evaluating U.S. Billion Dollar Weather Disasters*, 87 BULL. AM. METEOROLOGICAL SOC'Y 557 (2006).

8. *See* Susan M. Bernard & Michael A. McGeehin, *Municipal Heat Wave Response Plans*, 94 AM. J. PUB. HEALTH 1520 (2004) (describing the lack of preparedness of a number of American municipalities in coping with heat waves).

9. I confine my exploration to heat waves in the industrialized West. Yet heat wreaks havoc on the developing world, particularly when accompanied by long-term drought. For more information about the effects climate change may have on drought in Africa, see I.M. Held et al., *Simulation of Sahel Drought in the 20th and 21st Centuries*, 102 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 17891 (2005), *available at* http://www.pnas.org/cgi/reprint/0509057102v1.

10. IPCC, *supra* note 1, at 9.

The numbers of those who die from excess heat annually are already significant: more people die heat-related deaths annually in the U.S., on average, than from any other natural disaster.[11] Though most of us are simply uncomfortable when the temperatures rise, a much more dire consequence of excess heat is a rapid rise in mortality rates, particularly among the most vulnerable populations. The elderly, the poor, the socially isolated, and the mentally and physically ill are at the highest risk of dying of heatstroke and other heat-related illness. Average annual deaths by heat stroke between 1979 and 2003 conservatively total 354 and, in actuality, are likely closer to 1,800 per year.[12] In contrast, annual deaths from hurricanes total 149 (and would plummet to 21 deaths per year if not for the devastating gulf coast hurricanes of 2005).[13]

Nevertheless, heat waves rarely provoke a massive federal response. The 1995 Chicago heat wave is not even listed on the National Weather Service's top sixty-seven weather-related disasters from 1985-2003 because the compilation of top disasters is based only on whether the disasters caused damages exceeding a billion dollars, not on the number of deaths caused.[14] The 1980 heat wave is listed only because it was accompanied by widespread drought, causing massive agricultural losses. Yet, both the 1980 and 1995 Chicago heat waves rank among the deadliest U.S. natural disasters of the past twenty-five years.[15]

Current policy and academic attention to climate change is appropriately directed most intensely on efforts to stabilize and ul-

---

11. Whether deaths by heat waves should be considered "natural" is the subject of some debate. *See* discussion, *infra* Part II.B.

12. The 354 number comes from the National Center for Health Statistics' mortality data, *available at* http://www.cdc.gov. This number is, in fact, quite conservative because it is based only on deaths due to heat stroke. Researchers have long known that casualties from other causes, including respiratory and cardiac illnesses, increase in periods of intense heat. Researchers estimate that annual excess mortality as a result of heat, including deaths other than those due directly to heat stroke, total approximately 1800. *See* Kalkstein & Greene, *supra* note 3, at 90. For a more extensive discussion of the two principal ways of measuring death due to excessive heat, see *infra* Part II.B.

13. *See* Lott & Ross, *supra* note 7, at 560.

14. *See* Tom Ross & Neal Lott, *A Climatology of 1980-2003 Extreme Weather and Climate Events*, NOAA TECHNICAL REPORT 2003-01 (2003), *available at* http://www1.ncdc.noaa.gov/pub/data/techrpts/tr200301/tr2003-01.pdf.

15. To put the disaster in perspective, Eric Klinenberg notes that only 300 people died in the Chicago Fire of 1871; the 1995 Chicago heat was nearly ten times more deadly than the 1994 Northridge, California earthquake and twenty times more deadly than 1992's Hurricane Andrew. KLINENBERG, *supra* note 4, at 10.

timately reduce carbon emissions in order to slow the earth's warming. Regardless of those efforts, warming is, and will continue to occur. Accompanying that warming will be more frequent and more intense episodes of extreme heat.[16] Even the most aggressive greenhouse gas reduction efforts will not protect us from some of the negative effects of higher temperatures. Thus, my aim here is to focus not on efforts to reduce carbon emissions but on how to mitigate one of the negative effects of warming – mortality caused by increased heat waves that will inevitably occur.

I aim, then, to explore strategies to mitigate and/or adapt to increased heat waves in the U.S. Central to any mitigation strategy is the need to understand why the general public and many policymakers pay little attention to the relatively large annual heat-wave death toll. I posit several explanations, drawing from research on risk perception, and ultimately conclude that the lack of property damage from excess heat helps explain why heat waves and heat-wave deaths recede quickly from our collective memory. Indeed, because heat waves cause no property damage, they directly affect a smaller absolute number of victims and generate neither destructive media images nor government sponsored cleanup efforts. As a result, heat waves are less memorable events and, as risk perception studies would predict, recede quickly from our collective memory. I conclude by highlighting heat wave mitigation strategies and linking them to what we know from risk perception literature in order to improve their effectiveness.

II.
HEAT WAVE DEFINITIONS

A. *Heat waves.*

Government agencies and the American Red Cross generally define heat waves as extended periods of time, typically forty-eight to seventy-two hours and longer, with excessive heat and humidity.[17] A heat index is used to determine excessive heat,

---

16. The IPCC Fourth Assessment concludes that warming is already occurring and that we're already experiencing more frequent and intense episodes of heat. *See* IPCC, *supra* note 1.

17. *See, e.g.*, websites of American Red Cross, http://www.redcross.org/services/hss/tips/heat.html (last visited Jan. 27, 2007) (defining heat wave as temperatures above ninety degrees with eighty percent humidity for at least forty-eight hours); Federal Emergency Management Agency, http://www.fema.gov/hazard/heat/

taking into account both temperature and humidity. Research suggests that a particularly important condition contributing to increased morbidity is several consecutive very warm evenings with little wind and little relief from maximum daily temperatures.[18] Excessive heat appears to differ regionally so that a precise definition of a heat wave includes sustained maximum temperatures in excess of average temperatures in a particular area.[19] Even more sophisticated analyses go beyond just measuring temperature and humidity, incorporating types of air masses that surround particular geographic areas to predict the mortality effects of heat waves.[20]

Several other definitional points are important. Residents of urban areas tend to fare particularly badly in heat waves, in large part because the "built" environment absorbs and retains heat.[21] And residents of northern cities in the U.S. are at a higher risk of mortality from excessive heat than residents of southern cities even though southern cities have on average higher temperatures than northern ones (conversely residents of southern cities fare worse in extremely cold temperatures compared with their northern counterparts).[22]

B. *Heat-related illnesses and mortality*

Estimates of deaths as a result of excess heat come from two separate sources. Some counts include only those deaths where a death certificate lists excessive heat or heat stroke as a cause of death. These are the deaths included in the National Weather Service's estimate of average annual weather fatalities.[23] Heat

---

heat_terms.shtm (last visited Jan. 27, 2007) (defining heat wave as "prolonged period of excessive heat, often combined with humidity.").

18. Gerald A. Meehl & Claudia Tebaldi, *More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century*, 205 SCI. 994 (Aug. 2004).

19. *Id.*

20. *See* Kalkstein & Greene, *supra* note 3, at 90.

21. *See* Jonathan A. Patz et al., *The Potential Health Impacts of Climate Variability and Change for the United States*, 108 ENVTL. HEALTH PERSP. 367, 370 (2000); *cf.* Scott C. Sheridan, *Heat-Related Mortality: A Rural Problem Too*, 83 BULL. AM. METEOROLOGICAL SOC'Y 1466 (2002).

22. Frank C. Curriero et al., *Temperature and Mortality in 11 Cities of the Eastern United States*, 155 AM. J. EPIDEMIOLOGY 80, 83-84 (2002); Michael A. McGeehin & Maria Mirabelli, *The Potential Impacts of Climate Variability and Change on Temperature-Related Morbidity and Mortality in the United States*, 109 ENVTL. HEALTH PERSP. 185, 186 (SUPP. 2 2001) ("tolerance of excess heat varies regionally according to the population and its preparedness for heat and according to the local average temperatures and frequency of extreme temperatures.").

23. http://www.nws.noaa.gov/om/hazstats.shtml.

stroke occurs when the body heats to at least 105 °F and cannot cool itself. Heatstroke happens quite quickly and causes increasingly serious symptoms, including disorientation, delirium and coma.[24] Those who survive heat stroke are at high risk for organ failure and death within a year.[25]

But heat stroke is not the only cause of increased mortality during a heat wave. Researchers have long noted that average daily death rates increase rapidly during the second or third day of a heat wave and stay elevated during the period of prolonged heat. Individuals with cardiac disease, for example, are at higher risk of death during heat waves because excess heat creates pressure on the cardiovascular system to cool the body; similarly, those suffering from respiratory ailments have an increased risk of death because heat waves are often accompanied by increases in air pollution and small particulate matter.[26] Thus, many death counts for heat waves are calculated by using an "excess mortality" measure, which basically involves subtracting the "expected" mortality (based on historical averages) from actual daily death rates.[27] Deaths from means other than heat stroke during heat waves are typically a much higher percentage than heat stroke deaths. For example, about a quarter of the deaths in the French heat wave of 2003 were heat stroke related,[28] and about twenty percent of the 10,000 deaths from a massive heat wave in the U.S. in 1980 were caused by heat stroke.[29] In the Chicago heat wave, however, a much larger percentage of the deaths, about 70%, were caused directly by heat.[30]

---

24. McGeehin & Mirabelli, *supra* note 22, at 185.

25. *Id.*

26. Curriero et al., *supra* note 22, at 80; M. Poumadere et al., *The 2003 Heat Wave in France: Dangerous Climate Change Here and Now*, 25 RISK ANAL. 1483, 1486 (2005) (researchers estimate that 379 people died in nine large French cities between August 3-17 from high concentrations of ozone).

27. *The Health Impacts of 2003 Summer Heat-Waves: Briefing Note for the Delegations of the Fifty-third Session of the WHO Regional Committee for Europe*, 53 WORLD HEALTH ORG. REGIONAL COMMITTEE FOR EUR. 1, 4 (2003), *available at* http://www.euro.who.int/document/Gch/HEAT-WAVES%20RC3.pdf (last visited Jan. 27, 2006); Kalkstein & Greene, *supra* note 3, at 87.

28. Kosatsky, *supra* note 5.

29. KLINENBERG, *supra* note 4, at 17; E-mail from Neal Lott, National Oceanic and Atmospheric Administration, to Ann E. Carlson, Professor of Law, UCLA School of Law (July 21, 2006) (on file with author) (explaining that "deaths directly caused by heat stroke during 1980 were estimated to be 2000 or less" of the 10,000 deaths Lott reports in Lott & Ross, *supra* note 7).

30. KLINENBERG, *supra* note 4, at 9.

It is worth noting here that a common reaction to heat-wave deaths, both among members of the public and among researchers, is to wonder whether the deaths from excess heat occurred among either elderly or ill individuals who were "about to die anyway."[31] Researchers term deaths that have been accelerated by a short amount of time "mortality displacement"[32] or "harvesting."[33] Evidence of mortality displacement comes from determining whether death rates in the days and months following a heat wave decline below average levels. The evidence is not clear-cut. In an analysis of the 1995 Chicago heat wave, the Illinois Department of Public Health found no evidence of mortality displacement after examining two years' worth of Chicago death rates.[34] Other research suggests that between 20 and 40% of heat-wave deaths "represent short-term mortality displacement."[35] In an extensive analysis of whether "harvesting" occurred during the French 2003 heat wave, researchers found no clear evidence of mortality displacement. Indeed, researchers concluded that heat-wave victims had an average remaining life expectancy of almost eight years.[36]

C. *Demographics*

1. Individual characteristics

The individual demographics of those at highest risk during a heat wave are not surprising in many respects. The most vulnerable suffer disproportionately: the elderly, the disabled, the ill, the poor, and the socially isolated.

Age is indisputably a major risk factor for heat-related deaths. Nationwide, from 1979-1998 the excessive heat death rate was 7.4 times higher for those aged 65 and older than for their younger counterparts.[37] During the 1995 Chicago heat wave, 73% of the victims were over the age of 65; in Europe's 2003 heat wave

---

31. KLINENBERG, *supra* note 4, at 30.

32. *See, e.g.*, Yuguan Bailey Shen, *In and Out of the Hot Zone: A Study of Heat Wave Mortality Displacement* (2004); Kosatsky, *supra* note 5 (reviewing evidence of mortality displacement in 2003 heat wave in Europe).

33. Toulemon & Barbieri, *supra* note 5, at 9 ("the harvesting or frailty effect is defined as a selection effect of mortality among the frailest individuals such that the heat wave victims were fated to die within weeks or months . . . in the absence of the heat wave.").

34. KLINENBERG, *supra* note 4, at 30; *but see* Shen, *supra* note 32.

35. Kalkstein & Greene, *supra* note 3, at 91.

36. Toulemon & Barbieri, *supra* note 5, at 20.

37. *Heat-Related Deaths – Los Angeles County, California, 1999-2000, and United States, 1979-1988*, 286 J. AMER. MED. ASS'N 911 (2001).

eighty percent of the French victims were 75 or older (although the death rate in France was 27% higher than normal for men aged 35 to 44 during the heat wave and 23% higher for women aged 45 to 54).[38] Despite pronouncements to the contrary,[39] at least in contemporary heat waves, extreme youth does not appear to be a risk factor as it was at the turn of the 20th century when infants with preexisting conditions like respiratory tract infections died disproportionately.[40] No one under the age of 18 died in St. Louis or Kansas City in the 1980 heat wave,[41] and in their multi-city, multi-year analysis of heat-wave deaths in the U.S., Kalkstein and Davis found no evidence that children under the age of four were at higher risk of death due to heat exposure.[42] The demographics of those who perished in the 2006 heat wave in California's Central Valley, the deadliest heat wave in the state in 50 years, appear to be somewhat outside the norm. Fewer than 50% of the victims were over the age of seventy and many victims died outside, often at work.[43] In this respect the demographics of the Central Valley heat wave appear to be more similar to heat waves early in the 20th century, where physical laborers were at high risk for heat stroke.[44]

Advancing age is not the only risk factor. In the U.S., those who die in heat waves are at least twice as likely to have been isolated socially – defined not only by living alone, but also by not leaving home on a daily basis.[45] In Eric Klinenberg's extensive "social autopsy" of the 1995 Chicago heat wave, he examined police reports of many of those who had died due to the

38. Toulemon & Barbieri, *supra* note 5, at 8; M. Poumadere, *supra* note 26, at 1485.

39. *See, e.g.*, Centers for Disease Control and Prevention, Extreme Heat: A Prevention Guide to Promote Your Personal Health and Safety, *available at* http://www.bt.cdc.gov/disasters/extremeheat/heat_guide.asp (last visited Jan. 27, 2007) ("The elderly, the very young . . . are at highest risk" of heat-related illness or death.).

40. T. Stephen Jones et al., *Morbidity and Mortality Associated with the July 1980 Heat Wave in St. Louis and Kansas City, MO*, 247 J. AM. MED. ASS'N. 3327, 3330-31 (1982).

41. *Id.* at 3330.

42. Laurence S. Kalkstein & Robert E. Davis, *Weather and Human Mortality: An Evaluation of Demographic and Interregional Responses in the United States*, 79 ANNALS OF AMER. GEOGRAPHY 44, 52 (1989).

43. Jennifer Steinhauer, *For Californians, Deadly Heat Cut a Broad Swath*, N.Y. TIMES, Aug. 11, 2006.

44. Jones et al., *supra* note 40, at 3331.

45. Mary. P. Naughton et al., *Heat-related Mortality During a 1999 Heat Wave in Chicago*, 22 AM. J. PREVENTIVE MED. 221, 225 (2002); KLINENBERG, *supra* note 4, at 46.

heat. The accounts of their deaths are often depressingly similar, involving elderly persons living alone with little social contact. The words of the police reports are telling: "known as quiet, kept to himself," a "recluse," "hadn't seen [daughter] in years."[46] Oddly, however, researchers found no evidence that social isolation was a risk factor in the French heat wave of 2003. Indeed, older people who lived alone "appeared *less* likely to be at risk."[47]

Poverty is also correlated with higher than average heat-related deaths. In St. Louis and Kansas City during the catastrophic 1980 heat wave, those residing in low-income census tracts were almost six times more likely to suffer heat stroke than residents of the highest income tracts.[48] Seventy two percent of the victims of the 1999 Chicago heat wave had annual incomes of less than $10,000.[49] In an analysis of all heat-related deaths in eleven large eastern cities between 1973 and 1994, researchers found a significant correlation between persons living in poverty and mortality risk.[50] Additionally, French researchers found that "lower social class status was an important determinant" of heat wave mortality in 2003.[51]

Illness, both mental and physical, is another strong predictor of mortality in a heat wave. Half of all of the victims studied in the 1999 Chicago heat wave suffered from some form of mental illness and almost two-thirds had heart conditions.[52]

The data about several other risk factors is less clear cut. For example, the evidence about whether men or women fare worse in heat waves is mixed. The 1995 Chicago heat wave proved particularly hard on men: 55% of victims were men and the age-adjusted rate indicated that men were more than twice as likely to die as women of the same age.[53] The 2003 French heat wave, by contrast, hit women harder: 70% of the victims were female.[54]

46. KLINENBERG, *supra* note 4, at 40-41.

47. Jim Ogg, *Implications of the 2003 French Heat Wave for the Social Care of Older People* (Young Foundation, Working Paper No. 2, 2005) (on file with author).

48. Jones et al., *supra* note 40, at 3330.

49. Naughton et al., *supra* note 45, at 225; curiously, income status was not analyzed in the 1995 heat wave. *Id.* at 226.

50. Curriero et al., *supra* note 22, at 85.

51. Ogg, *supra* note 47, at 19.

52. Naughton et al., *supra* note 45.

53. KLINENBERG, *supra* note 4, at 19-20.

54. Ogg, *supra* note 47, at 16.

The evidence about the effect of race on mortality rates is also complex. In both significant Chicago heat waves in the 1990s, African Americans died in disproportionately high numbers. Just over half of the 1999 victims were African American[55] and in the 1995 Chicago heat wave African Americans had the highest proportional death rate of any racial group.[56] The heat wave of 1980 hit St. Louis and Kansas City particularly hard, and researchers found that non-whites suffered higher rates of heat stroke but could not separate the effects of poverty from race.[57] In an analysis of mortality rates in 48 cities from 1964-1980, however, researchers found no racial disparity in death rates on a national level – though they did find that whites were more likely to be victims of heat in the northeast, as were African Americans in the south.[58] Equally surprising, Latinos in both of the 1990s Chicago heat waves fared disproportionately *better* than other racial and ethnic groups, including whites.[59]

D. *Place and Space Matter*

1. Geographic Differences

As with many natural disasters, where and how one lives frequently matter at least as much as one's race, gender, age or economic status (though of course these factors are not unrelated). Residents of Boston do not suffer in earthquakes, at least to date, and Southern Californians are not typically the victims of tornadoes, hurricanes and excessively cold weather. And, just as tornadoes, hurricanes and earthquakes affect particular regions of the country either exclusively or disproportionately, so do heat waves. To put it a slightly different way, excessive heat, though it may strike cities and states across the country, affects regions very differently. The hottest parts of the country are *not* those most at risk for high death rates during periods of high temperatures; on the contrary, "in the warmer regions of the nation, it

---

55. Naughton et al., *supra* note 45, at 225.

56. KLINENBERG, *supra* note 4, at 19.

57. Jones et al., *supra* note 40, at 3330.

58. Kalkstein & Davis, *supra* note 42, at 56.

59. Naughton et al., *supra* note 45, at 224; *see* also JC Semenza, CH Rubin, et al, , *Heat Related Deaths During the July 1995 Heat Wave in Chicago*, 335 NEW ENGLAND J. MED 84, 86; KLINENBERG, *supra* note 4, at 87.

generally appears that people do *not* respond negatively to heat even under the most severe conditions."[60]

Two explanations, one physiological and one structural, help make sense of the differential regional responses to heat waves. Structurally, hotter portions of the country have air conditioning in much greater percentages. Air conditioning has a significant and positive effect in protecting against heat stroke.[61] Only 58% of New England households have some sort of air conditioning (either central or room units).[62] Eighty-one percent of households in the South Atlantic region of the country, by contrast, use central air, and another 14% have individual room air-conditioning units for a total of 95%.[63] Air conditioning likely accounts for only part of the differential response to heat, however, and may not be as protective as one might expect. Researchers have found, for example, little change in mortality rates from heat over a 30 year period in New York City despite large increases in air-conditioning use.[64]

Instead, physiological factors may play an important role in helping the human body acclimate to higher temperatures. Repeated exposure to high temperatures appears to protect individuals against negative reactions to high heat. Residents of areas of the country that are generally cooler, but also experience excessive heat and humidity on occasion, fare much worse than residents of areas of the country that experience high heat and humidity regularly. However, particularly vulnerable residents of high temperature areas, including the homeless and immigrants attempting to cross the border, may face heightened risk.[65]

60. Kalkstein & Davis, *supra* note 42, at 56-7 (emphasis in original); *see also* Curriero et al., *supra* note 22, at 83 (evaluating 11 eastern cities and finding "for the southern cities . . . little increase in mortality risk for the hottest days").

61. Curriero et al., *supra* note 22, at 86; Naughton et al., *supra* note 45, at 224-25.

62. U.S. DEPARTMENT OF ENERGY, ENERGY INFORMATION ADMINISTRATION, APPLIANCES IN U.S. HOUSEHOLDS, SELECTED YEARS, 1980-2001, *available at* http://www.eia.doe.gov/emeu/reps/appli/all_tables.html (last visited July 17, 2007).

63. U.S. DEPARTMENT OF ENERGY, ENERGY INFORMATION ADMINISTRATION, SOUTH ATLANTIC HOUSEHOLD ELECTRICITY REPORT (2006), *available at* http://www.eia.doe.gov/emeu/reps/enduse/er01_so-atl.html (last visited Jan. 27, 2007).

64. *See* Kalkstein & Davis, *supra* note 42, at 46.

65. Those who lack air conditioning or the means to use it, the homeless, and immigrants attempting to enter the country in the southwest all face higher risk. *See, e.g.*, Marie Szaniszlo, *In the Heat of the Moment*, THE BOSTON HERALD, July 8, 2007, at 2 (reporting that the bodies of six immigrants, likely victims of excess heat while crossing the border, were found in Southern Arizona during the first week of July 2007); Fay Bowers, *Sun-scorched Phoenix Takes More Heart for Its Homeless*, CHRISTIAN SCIENCE MONITOR, July 9, 2007, at 1 (reporting that at least 30 homeless

Providing further evidence that humans acclimate to higher temperatures, heat wave mortality is at its highest earlier in the summer; later heat waves tend not to be accompanied by high death rates.[66]

Not only do residents of some regions of the country fare worse in excessive heat than others, but residents of urban areas fare worse than their rural counterparts. During the 1980 heat wave in St. Louis, death rates were higher in the more densely urban areas of the city,[67] and the most severe heat waves in U.S. history have occurred in cities.[68] Urban areas retain heat throughout the day and evening and temperatures can be as much as ten degrees hotter in cities than in nearby rural areas.[69] Heat retention is caused by a number of factors, including: extensive use of heat-retaining, slow-cooling surfaces, like concrete; the presence of dark surfaces (including roads) that absorb heat; decreased wind speeds, because of tall buildings; and the elimination of natural surfaces that absorb water, leading to less air-cooling evaporation.[70]

2. Intra-urban Differences

Even within urban areas some residents are at higher risk than others. Urbanites with air conditioning fare well; those without it do not. Contrary to previous beliefs, fan use in the absence of air conditioning does not reduce the risk of heat stroke and premature death. Indeed, running a fan inside a hot home without air

---

people died during a 2005 heat wave and describing risks homeless people have faced during July 2007's record Phoenix heat); Jeannie Kever, *Cool Down: Summer's Here and Heat is on; Struggling with Electric Bills? Help is Out There*, THE HOUSTON CHRONICLE, June 17, 2007, at 1 (describing 46 deaths in Harris County, Texas over a five year period and quoting city officials who believe many of the deaths occurred because of refusal to use air conditioning due to high electricity costs).

66. Kalkstein & Davis, *supra* note 42, at 46, 56. Another possible explanation for the decline in heat-wave deaths later in the summer is that, since some of the most susceptible individuals have already died in an earlier heat wave, the population of potential victims later in the summer is smaller. *Id.* at 46.

67. Jones et al., *supra* note 40, at 3330.

68. Larsen, *supra* note 5.

69. *See* U.S. ENVTL. PROT. AGENCY, HEAT ISLAND EFFECT, http:// yosemite.epa.gov/ oar/globalwarming.nsf/content/ActionsLocalHeatIslandEffect.html (last visited Jan. 27, 2007).

70. ActionBioscience.org, James A. Voogt, Urban Heat Islands: Hotter Cities (2004), http://www.actionbioscience.org/environment/voogt.html (last visited Jan. 27, 2007).

conditioning can exacerbate dangerous heat conditions.[71] Living on the top floor of a high rise, particularly one without air conditioning, also increases the risk of heat stroke.

Most heat wave research thus far has focused on the urban/rural risk differential, rather than differences amongst urban areas. In Klinenberg's social autopsy of the 1995 Chicago heat wave, however, he examined neighborhood composition within Chicago to determine why Latinos, including poor and elderly residents of urban Chicago, fared so much better than poor and elderly African American residents of Chicago. He found that standard explanations for the differential outcomes, both physiological and cultural, did not hold up to scientific evidence. Many of those he interviewed assumed that Latinos fared well because they were physically better capable of coping with intense heat. Some Latinos told Klinenberg, for example, that "there is something in our skin or our genes that makes us a little bit more comfortable with the heat."[72] Though this view is apparently widely held, it is unsupported by research.[73]

There is also a standard cultural explanation for why Latinos may have fared better in the Chicago heat waves: Latino families tend to have strong intergenerational connections, and are therefore less likely to be at risk for the isolating factors that contribute to heat-wave deaths. Klinenberg also rejects this cultural explanation, both because native-born Latinos are more likely to be socially isolated than immigrants and because African Americans – who suffered disproportionately in both heat waves – also have strong extended family ties.[74]

Klinenberg offers a more striking geographic explanation for the disparate outcomes of the various ethnic groups. His explanation – what he calls "a place-specific social ecology and its effects on cultural practices" – presents a more complex challenge for those seeking to mitigate the effects of heat waves. Klinenberg compared two communities with comparable rates of poverty and percentages of seniors,[75] one almost exclusively Af-

71. Scott C. Sheridan, *A Survey of Public Perception and Response to Heat Warnings Across Four North American Cities: An Evaluation of Municipal Effectiveness*, 52 INT'L J. BIOMETEOROLOGY (2006), *available at* http://sheridan.geog.kent.edu/pubs/2006-IJB.pdf (last visited Jan. 27, 2007).

72. KLINENBERG, *supra* note 4, at 89.

73. *Id.*

74. *Id.*

75. The demographics of the two neighborhoods, North Lawndale (96% African American) and South Lawndale (85 % Latino, 94 % minority), though similar, do

rican American (North Lawndale) and the other predominantly Latino (South Lawndale or "Little Village"), that experienced radically different impacts from the 1995 heat wave. The African American community suffered nineteen casualties, the Latino only three. Klinenberg concluded that, in North Lawndale, a combination of declining jobs and population and high residential turnover has created a physical landscape that is dilapidated, empty of community activity, and a haven for crime.[76] North Lawndale residents, as a result, feel physically insecure outside of their homes, particularly at night, and therefore experience social isolation in a way that makes them more vulnerable to excess heat.[77]

Little Village, despite high poverty rates, has much less crime (three times less than North Lawndale); a bustling commercial economy with nearby housing has resulted in the community activity and street life lacking in North Lawndale. Klinenberg concludes that seniors in Little Village are more likely to be drawn outside, into stores and other buildings that during a heat wave are cooler and often air-conditioned. And those seniors who need help because of excessive heat are more likely to make contact with those who can help them rather than remain alone and isolated.[78]

Klinenberg's comparison is not meant to be based on statistically sophisticated empirical evidence – he compares just two neighborhoods and the numbers of deaths are likely too small to draw robust conclusions. Nevertheless, his observations are provocative and tell a story consistent with demographic information about the effects of age and social isolation on risk of heat stroke. They also raise interesting questions about predicting and managing risk during heat waves, questions to which I return in Part IV.

Out of all of this demographic and geographic information some clear-cut patterns emerge: low-income, socially isolated seniors with mental or physical health problems who live in neglected parts of cities and lack air conditioning are at highest risk for death due to excessive heat. These risk factors are not a nec-

---

differ in some important respects. The rate of poverty in North Lawndale is twice that of South Lawndale and the percentage of seniors living in North Lawndale is more than double. The difference in crime rates is also dramatic (North Lawndale's is about three times higher than Little Village's). *Id.* at 87.

76. *Id.* at 90-109.

77. *Id.*

78. *Id.* at 109-124.

essary condition for death by heat stroke. Every heat wave with large casualties includes middle-aged deaths, deaths of seniors who are well-connected and looked-after, seemingly healthy people, and rural or suburban victims. But, the individual characteristics of the victims help tell a story not only about who is at risk, but also about how we can help them. Before turning to whether we systematically can and do prevent heat-wave deaths, I turn next to what we know about climate change and predictions for future episodes of intense heat.

III.
CLIMATE CHANGE AND HEAT WAVES

Heat waves already cause more deaths annually than any other "natural" disaster in the U.S. Whether predicted temperature increases caused by climate change will lead to more annual deaths is not entirely clear and obviously dependent upon whether we make significant reductions in greenhouse gas emissions. The best evidence to date, however, suggests that we will experience more intense, more frequent, and potentially longer-lasting heat waves absent a significant reduction in greenhouse gas emissions.[79]

Scientific models predict that the temperature increases we have already experienced in the twentieth century will be dwarfed by increases in the twenty-first century. While temperatures have increased over the course of the last century by close to a full degree Fahrenheit, models predict that the country will experience average temperature increases of between 5 °F and 9 °F by the end of this century.[80] Higher temperatures alone do not necessarily mean an increase in mortality, as a number of conditions, including humidity and high evening temperatures, create the deadliest heat waves.[81] Climatologists expect, however, that these deadly factors will combine more regularly with increasing temperatures.[82]

Climate change is predicted to affect different regions of the country differently. The West, for example, is expected to see

79. Meehl & Tebaldi, *supra* note 18.

80. National Assessment Synthesis Team, *Climate Change Impacts on the United States The Potential Consequences of Climate Variability and Change*, U.S. GLOBAL CHANGE RESEARCH PROGRAM (2000) at 7, 10, *available at* http://www.usgcrp.gov/usgcrp/Library/nationalassessment/00Intro.pdf (last visited Jan. 27, 2007).

81. *See supra* Part II.A, for a discussion of the definition of heat wave.

82. Meehl & Tebaldi, *supra* note 18, at 994-95.

very large temperature increases: 3 to 4 °F by the 2030s, and 8 to 11 °F by the 2090s.[83] These increases are expected to be accompanied by more intense heat waves.[84] Climatologists predict the smallest temperature increases in the Northeast, but nevertheless expect temperature increases as high as 9 °F by 2100. In virtually every region of the country, models predict more intense and more frequent heat waves.[85]

Accompanying those heat waves, scientists predict, will be large increases in summer mortality.[86] The most conservative model predicting climate-change related mortality predicts a summer mortality increase of more than seventy percent by 2050. All of the models predict that the cities of the Northeast and Midwest (e.g., New York, Philadelphia, Detroit, Chicago, and Minneapolis) will fare particularly badly.[87]

It is possible that in the face of rising temperatures we will adapt both physiologically and structurally. Physiologically, people may prove more resilient to heat as overall temperatures climb, just as residents of the Southeast fare better in high temperatures than residents of the Northeast. Even taking acclimatization into account, however, scientists still predict large increases in overall summer mortality rates.[88]

Structurally, as cooler areas of the country get warmer, housing is more likely to contain air conditioning. Some researchers predict that most U.S. cities will reach close to 100% air-conditioning coverage over the course of the next century.[89] Yet absent a change in public policy,[90] lack of air conditioning will likely remain a problem in urban areas with high poverty rates. In addition, unless summer energy rates are subsidized more heavily, many people will be reluctant to turn on their air conditioning.[91]

---

83. National Assessment Synthesis Team, *supra* note 80, at 65.

84. Meehl & Tebaldi, *supra* note 8, at 996.

85. *Id.*; *see also* National Assessment Synthesis Team, *U.S. National Assessment of the Potential Consequences of Climate Variability and Change, Regions and Mega-Regions*, U.S. GLOBAL CHANGE RESEARCH PROGRAM (2003), *available at* http://www.usgcrp.gov/usgcrp/nacc/background/regions.htm (last visited Jan. 27, 2007).

86. Kalkstein & Greene, *supra* note 3, at 85.

87. *Id.* at 90.

88. *Id.* at 88-89.

89. *Id.* at 91.

90. *See* discussion *infra* Part V.B.

91. Kalkstein & Greene, *supra* note 3, at 92; *see also* Sheridan, *supra* note 71 (finding in a telephone survey that a third of seniors surveyed in four North American cities consider cost in whether to use air conditioning during a heat wave).

Finally, more temperate winters may offset increased summer mortality to some extent. But winter deaths appear to be less temperature-related than summer deaths. Rather, winter death rates typically climb because of the seasonal prevalence of infectious respiratory diseases. Thus, climatologists do not believe winter death rates will decline by much in the face of warmer temperatures.[92]

The incidence of heat waves and heat-related deaths is likely to rise throughout the U.S. over the next century, and is expected to hit urban areas in the Midwest and Northeast most heavily. Whether more intense and more frequent episodes of heat will change our perceptions of heat waves as significant killers is unclear. I next examine why heat waves seem to fade rapidly from the collective consciousness as soon as these events are over.

IV.
HEAT WAVES AND PUBLIC PERCEPTION

Despite the fact that heat waves kill more people annually, on average, than any other natural disaster, they receive little public attention relative to their more dramatic counterparts like hurricanes and earthquakes. Obviously, the demographics of the victims of heat waves play a role in the lack of public attention: older, socially isolated, poor urban residents evoke less sympathy than random victims of other natural disasters. This is particularly true for deaths of elderly victims, who seem to provoke a "they would have died anyway" response with some regularity.[93] But, the status of the victims of heat waves cannot be the only explanation. Katrina's victims, by and large, were overwhelmingly poor and African American (and many were elderly), yet a significant amount of public attention (or at least media attention) has remained on New Orleans.[94] Though multiple factors undoubtedly contribute to the relative public indifference to heat-wave deaths, I suggest that the nature of heat waves as catastrophes helps explain a great deal. Insights from a vast body of literature on risk perception help support this view.

92. Kalkstein & Greene, *supra* note 3, at 90.

93. *See* Toulemon & Barbieri, *supra* note 5, at 7, 20.

94. I do not mean to suggest that the response to Katrina has been adequate or that the nature of the victims is irrelevant to the response; instead I mean merely to suggest that the victims of Katrina have remained in the public eye in a way that victims of heat waves typically do not.

Heat waves occur slowly and without significant drama. Unlike other natural disasters, including hurricanes, tornados and earthquakes, heat waves may not even be viewed as disasters or catastrophes by many of those who experience them.[95] A hot day to a healthy person working indoors with access to air conditioning is, to a great extent, simply inconvenient. A hot day isn't accompanied by hundred mile-per-hour winds, shaking earth, or blizzarding snow. Schools are not shut down and roads are not made impassable. Buildings don't collapse. Life goes on normally for most people except for minor adjustments to their day to day behavior. For this reason, heat has been described as a silent killer.

The field of risk perception attempts to determine why and how people respond to risky events, including natural disasters like heat waves. Related to the field of risk perception is traditional risk analysis, which evaluates the probability of an event occurring at a certain magnitude.[96] The field of risk perception is concerned with two separate questions: whether the lay public systematically misestimates the risks of various types of activities (including natural and manmade) and, if so, what can or should be done about the misestimations.[97] Dan Kahan and Paul Slovic put it nicely: "[w]hat we are all trying to figure out . . . is how popular risk perceptions influence political responses to risk and what normative significance the law should give to such percep-

---

95. As Eric Klinenberg said about the 1995 Chicago heat wave, "the heat wave created crises for only a small and politically marginal portion of the city." KLINENBERG, *supra* note 4, at 165.

96. *See* Ortwin Renn, William J. Burns, Jeanne X. Kasperson, Roger E. Kasperson & Paul Slovic, *The Social Amplification of Risk: Theoretical Foundations and Empirical Applications*, 48 J. SOC. ISSUES 137, 138 (1992). Legal scholars have weighed into the risk perception debate by evaluating how the legal and political systems ought to respond to the fact that lay perceptions often diverge – sometimes dramatically – from expert assessments. The current focus in the legal academy for the most part is concerned with situations that provoke exactly the opposite response than heat waves do – what Cass Sunstein calls "risk panics" driven by irrational public fear over risks they perceive as much larger and more likely than expert estimates. Examples include mad cow disease and the reaction to toxic contamination at Love Canal. These risk panics lead, in Sunstein's view, to bad public policies, policies that interfere with sensible action on highly visible but low likelihood events. CASS SUNSTEIN, LAWS OF FEAR: BEYOND THE PRECAUTIONARY PRINCIPAL 35-63 (2005). For an interesting attempt to bring lessons from environmental policy analysis to risk assessment, *see* Matthew D. Adler, *Policy Analysis for Natural Hazards: Some Cautionary Lessons from Environmental Policy Analysis*, 1 DUKE L. J. 1 (2006).

97. Cass Sunstein provides a detailed account of this literature in SUNSTEIN, *supra* note 96.

tions."[98] If the public generally does a poor job of estimating risk, it can do so in separate directions, that is by overestimating the risk of certain activities (air travel, for example) and by underestimating the risk of others (such as automobile driving). From a policy perspective, poor public estimations of risk can lead either to regulatory excess or regulatory neglect.[99]

Though academics have studied a host of activities and events in an effort to measure the difference in actual risk versus perceived risk, heat waves have been the focus of only limited study. Scott Sheridan has surveyed elderly residents of several states to determine how they respond to heat warnings, a study I return to below. No one has studied, more generally, whether the public systematically underestimates the likelihood of death or other dangers associated with heat. Nevertheless, risk perception literature is useful in that it analyzes the types of factors likely to lead to erroneous estimations of risk. These factors strongly suggest that individuals will routinely underestimate the risk of excess heat on mortality. Moreover, the factors suggest that individuals are likely to view heat as less deadly than other more dramatic natural disasters (though I do not mean to suggest that the public *overestimates* the risk of other natural disasters, merely that individuals view heat waves as less problematic than more visibly damaging natural disasters like earthquakes and hurricanes even though heat waves are on average much more deadly year in and year out).

Virtually all risk scholars agree that one of the most useful insights for understanding how lay persons evaluate risk comes from Amos Tversky and Daniel Kahneman's seminal work on cognitive heuristics. Tversky and Kahneman were the first to put a label, the "availability heuristic," on the tendency of people to underestimate the likelihood of an event if the event is not vivid, sensational, or emotional (or, conversely, to overstate the likeli-

98. Dan M. Kahan and Paul Slovic, *Cultural Evaluations of Risk: "Values" or "Blunders"?*, *available at* http://www.harvardlawreview.org/forum/issues/119/feb06/kahan_slovic.pdf.

99. *See* HOWARD MARGOLIS, DEALING WITH RISK: WHY THE PUBLIC AND EXPERTS DISAGREE ON ENVIRONMENTAL ISSUES 1, 5 (1996) ("Every knowledgeable reader will be able to think of policy areas where what we are choosing as a society runs contrary to what almost everyone with close knowledge of the topic thinks makes much sense. We spend generously on programs that virtually no well-informed person thinks can accomplish much. We are unable to muster support for other programs which promise much more, in part because such discretionary spending as is available is preempted by spending on programs that will go nowhere.").

hood of a dramatic and spectacular event occurring). Thus, the availability heuristic explains why the public tends to overestimate the likelihood of death by dramatic means (accidents, homicides, tornadoes, fires) and to underestimate death by less visible means (suicide, stroke, tuberculosis).[100] Drama or vividness is not the only relevant factor in making an event more "available;" recent experience matters – events further away in time are less salient. Familiarity can matter as well, so that highly familiar activities (driving, smoking) can seem less risky than more exotic and unfamiliar ones (toxic waste exposure, nuclear reactor meltdown).[101]

Of course, lay opinion about risk does not occur in a vacuum. Opinions and perceptions are formed based on a complex interaction between psychological, cultural and social factors. Risk can be either "socially amplified" or "socially attenuated" through the ways in which particular events are portrayed publicly.[102] Numerous factors explain why society reacts to risky events, but media coverage is obviously an important one. In an extensive analysis of the coverage of 128 events, including biological hazards, rare catastrophes, common killers, and natural hazards (but not heat), researchers found that, although the number of casualties an event caused is an important factor in both risk perception and media coverage, the extent of human impact is a more important determinant.[103] In a separate analysis of newspaper coverage and public risk perception, Combs and Slovic evaluated how frequently a large number of causes of death were reported. Deaths by disease were significantly underreported compared with their probability of occurrence, while

---

100. Amos Tversky & Daniel Kahneman, *Availability: A Heuristic for Judging Frequency and Probability*, 5 COGNITIVE PSYCHOLOGY 207, 228 (1973). Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, 185 SCI. 1124, 1127 (1974); *see also* PAUL SLOVIC, THE PERCEPTION OF RISK 14 (2002) (describing the availability heuristic as "one of the most important ideas for helping us understand the distortions likely to occur in our perception of natural hazards"); Cass Sunstein, *The Laws of Fear*, 115 HARV. L. REV. 1119, 1125-27 (2002) (reviewing Slovic and describing availability heuristic).

101. *See* SUNSTEIN, *supra* note 101, at 37. With respect to how immediacy plays into risk estimations, as Sunstein describes, people living in flood plains tend not to buy flood insurance unless a major flood has occurred recently. *Id.*

102. *See* Renn, Burns, Kasperson, Kasperson & Slovic, *supra* note 96, at 139 (describing the social amplification of risk).

103. Jeanne X. Kasperson, Roger E. Kasperson, Nick Pidgeon & Paul Slovic, *The Social Amplification of Risk: Assessing Fifteen Years of Research and Theory*, *in* NICK PIDGEON, ROGER E. KASPERSON & PAUL SLOVIC, THE SOCIAL AMPLIFICATION OF RISK 18 (2003).

deaths by violent and catastrophic means (other than from most natural disasters, which the authors excluded) were significantly over-reported. In a second experimental study, Combs and Slovic demonstrated that people significantly overestimate the chances of dying by accidents, homicides, fires, and tornadoes, and significantly underestimate the chances of dying by underreported causes like stroke, diabetes and tuberculosis.[104]

The findings of risk perception research help frame my exploration of why the public response to heat waves is rather lackadaisical. Central to each of the following three explanations is the invisibility of the damage done by excess heat.

A. *Disbelief and Blaming the Victims*

First, because many people have easy and readily available mechanisms to avoid the heat and experience heat merely as inconvenient and uncomfortable rather than potentially catastrophic, a common public reaction to heat-wave deaths may be not to believe that heat caused the deaths. Heat, in other words, is a much less noisy or visible killer than earthquakes, hurricanes, and tornadoes. The availability heuristic suggests, then, that the lack of vivid, available mental images of heat waves will lead to public underestimation of their risks.

During the 1995 Chicago heat wave, for example, in response to bodies piling up at local morgues, Mayor Richard Daley said, "Every day, people die of natural causes. You cannot claim that everybody who has died in the last eight or nine days died of heat."[105] Though he was ultimately proven wrong by extensive analysis showing that most deaths in Chicago during the heat wave were heat-related (indeed he later admitted his error),[106] Daley's comments may capture the sentiments of many. The fact that heat waves disproportionately affect the elderly, particularly socially isolated, elderly urban residents (many with pre-existing health issues) – also surely contributes to perceptions that heat waves are not crises of the same magnitude as more dramatic natural disasters. In fact, some heat related-deaths, especially among the very infirm, are only slightly premature. Accordingly, the occurrence of mortality displacement on a limited scale undoubtedly contributes to the general perception that heat deaths

---

104. Barbara Combs and Paul Slovic, *Newspaper Coverage of Causes of Death*, 56 JOURNALISM Q. 837, 839-40 (1979).

105. KLINENBERG, *supra* note 4, at 172.

106. *Id.* at 174.

are not "real." Even in heat waves in which mortality displacement occurs in relatively high percentages, however, only 20-40 percent of deaths can be attributed to this phenomenon.[107] Nonetheless, public perception may be that heat-wave victims are weak and atypical, and therefore victims of something other than excess heat.

A related, though distinct, phenomenon is to find fault with the behavior of heat-wave victims.[108] Heat waves victims are by no means distinct in having their blameworthiness assessed: former Federal Emergency Management Agency (FEMA) director Michael Brown attributed the high number of deaths caused by Katrina "to a lot of people who did not heed the advance warnings" to evacuate the gulf coast region.[109] Heat-wave victims may be particularly susceptible to blame, however, given the ease with which healthy people with access to air conditioning can cool themselves off. Chicago's Human Services Commissioner captured the sentiment at a press conference during the 1995 heat wave: "[w]e're talking about people who die because they neglect themselves."[110]

Though heat wave victims are not unique in either their demography or in public views of their moral culpability, the silent and stealthy nature of heat waves, combined with the relative ease with which their dire effects can be avoided, may be unique. It is certainly the case that more dramatic natural disasters wreak their havoc much more visibly and rarely leave doubt as to whether they are the cause of human mortality even if their victims can be assigned some blame.[111] It is not just the nature of the victims and how they die, however, that contributes to our tendency to overlook the destructive capacity of heat waves. The

---

107. *See* Kalkstein & Greene, *supra* note 3, at 91.

108. For an interesting account of the early history of federal disaster relief, see Michele L. Landis, *Let Me Next Time Be "Tried by Fire": Disaster Relief and the Origins of the American Welfare State 1789-1874*, 92 Nw. U. L. Rev. 967 (1998). Landis' central thesis is that the provision of early disaster relief corresponded with the degree to which victims of disasters could be viewed as blameworthy or blame free. Blameworthy victims, unsurprisingly, did not receive aid whereas those whose plights were considered fortuitous did. *Id.* at 969-71.

109. CNN.com, *FEMA Chief: Victims Bear Some Responsibility*, http://www.cnn.com/2005/WEATHER/09/01/katrina.fema.brown/ (last visited Jan. 27, 2007).

110. Klinenberg, *supra* note 4, at 172.

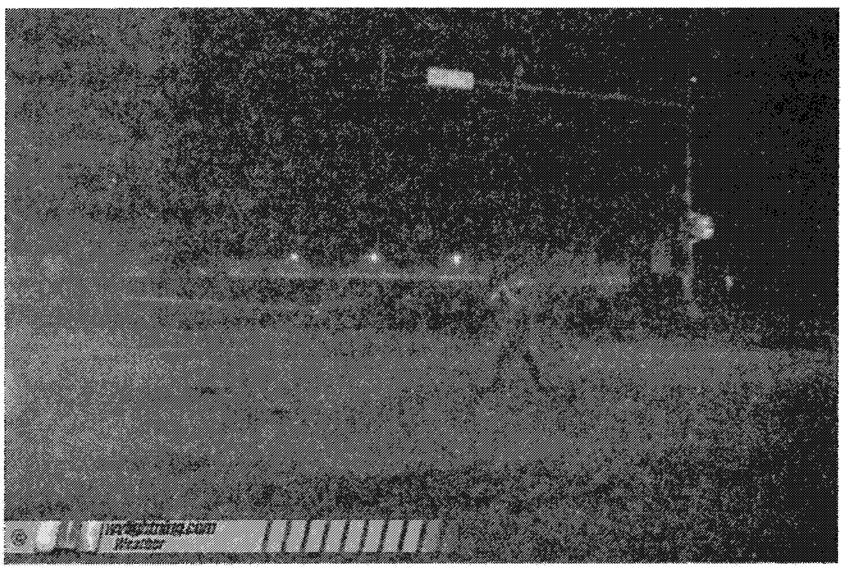
111. Except, perhaps, on the margins (for example when someone dies of a heart attack brought on by the stress and tension a hurricane or earthquake can cause).

stealthy nature of heat waves affects perceptions of their severity in additional ways.

B. *Invisibility of Damage and the Media*

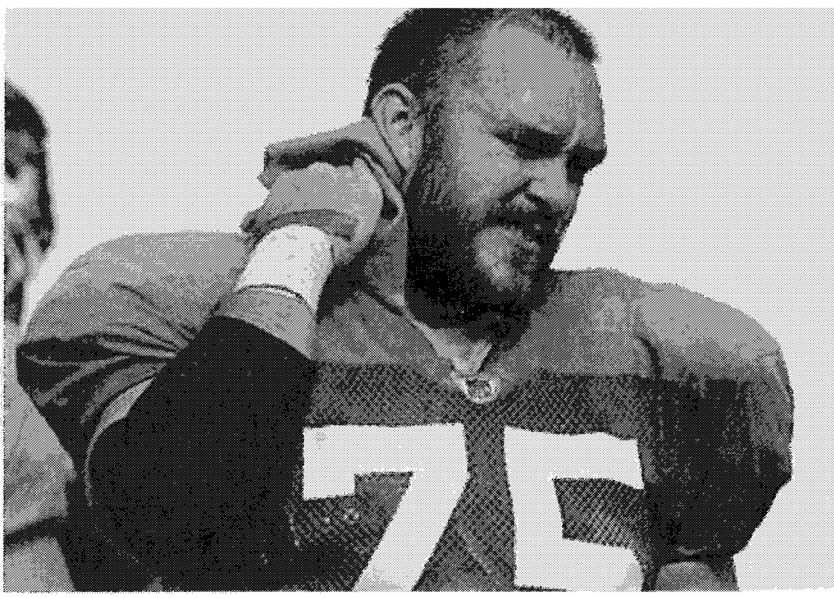
It seems almost banal to observe that media coverage of heat waves is less dramatic and less intensive than other natural disasters. This lack of coverage is important in shaping public perception about the severity of disaster. If heat waves are covered less vividly and frequently than other, more dramatic, disasters, risk perception literature helps explain why we may collectively view excess heat as less threatening than other natural disasters.

Hurricanes provide an easy counterexample to heat waves. They provide dramatic images during the event, immediately afterward, and – if particularly destructive – for months or even years later. The images below, from Hurricane Rita,[112] illustrate my point:



112. Photo 1 comes from http://wvlightning.com/rita/52.jpg (last visited Jan. 27, 2007); Photo 2 comes from http://community.theolympian.com/albums/album325/HURRICANE_RITA5.jpg (last visited Jan. 27, 2007); Photo 3 comes from http://www.cubahurricanes.org/images/photo/hurricane-rita.gif (last visited Jan. 30, 2007).

Earthquakes, forest fires, tsunamis, and other dramatic disasters offer similarly exciting media opportunities. Heat waves, by contrast, provide few images that illustrate the silent harm they create. Instead, media images frequently look something like this:



For the most part we never see the victims of heat waves.[113] No one appears on television bloodied or battered. The most uncomfortable images we see are of people sweating. Photos or

113. Contrast a search of "heat waves" in Google Images with a search of "hurricanes."

images of children playing in sprinklers or people at the beach are commonplace.[114] As I discuss in more detail in Section C below, importantly, heat waves cause little or no property damage.[115] The result is that the media has no footage of damaged buildings, flooded streets, collapsed freeways, or burning houses. Nor do the media have images of people affected by physical damage: those made homeless, trapped in flooded waters, or stranded because of road damage. Therefore, media images during a heat wave are necessarily less dramatic than those engendered by hurricanes, earthquakes and fires.

The lack of dramatic physical destruction also means that news coverage of a heat wave peters out much more quickly than coverage of a disaster that causes much more physical damage. A search of news databases is supportive. I searched Westlaw News for coverage of the Chicago heat wave of 1995 – during which 739 people died – from the time of the event to a year later. From the beginning of the heat wave to one month later, 256 articles appeared. Six months later only 65 new articles on the heat wave were published and a year later only 27 more had been added (so that a total of 348 articles were published in the year following the beginning of the heat wave).

I also searched Westlaw News for coverage of the Northridge earthquake of 1994 in which sixty-one people died. The earthquake caused about $20 billion in property damage. In the month immediately following the earthquake 760 articles were published. Six months later, an additional 1180 articles appeared and by a year after the earthquake a total of 2792 articles had been written (852 alone in the last six months, approximately 3.5 times as many as articles written about the Chicago heat wave as it was happening)

Media images of heat waves are, in sum, both less vivid and less frequent than images of other natural disasters that cause many fewer casualties but more property damage. Cognitive sci-

114. The photo of children playing in a fountain comes from http://www.cbsnews.com/images/2006/07/20/image08cccf3d-8f9d-4d6a-8fa3-e93c24731cc0.jpg (last visited Jan. 27, 2007); the photo of the football player sweating comes from http://msnbcmedia.msn.com/j/msnbc/Components/Photos/060802/060801_traning_hmed_3p.h2.jpg (last visited Jan. 27, 2007).

115. Here I distinguish heat waves from long term drought, in which heat waves can be enmeshed. Drought, obviously, can cause extensive property damage to crops and in impoverished parts of the world drought can cause massive human suffering.

ence suggests that, as a result, people will discount the likelihood of deaths by heat wave, at least in relation to other disasters.

C. *Heat Waves and Property Damage*

A third factor helps explain why heat waves, despite their deadly effects, get less attention than other natural disasters. Heat waves cause little or no property damage.[116] Major hurricanes, floods and earthquakes, by contrast, frequently cause significant property damage even when loss of life is relatively limited.[117] Property damage matters in several important respects, including the media coverage an event receives, the government response to the disaster, and the vastly larger number of victims (when victimhood includes loss of property). I stress at the outset that I do not intend to make a normative judgment here about whether the attention paid to natural disasters that cause extensive property damage is problematic; instead, my point is to analyze why deaths by heat wave receive relatively little attention and seem to fade quickly from public consciousness.

1. Media Coverage

For the media, as discussed above, property damage produces interesting images, images that persist long after the disaster has occurred. Property damage also produces stories: stories about families without housing,[118] stories about roads that have closed (think of the collapse of the San Francisco Bay Bridge in the 1989 Loma Prieta earthquake,[119] or the destruction of the Santa

116. Again, I am not including droughts here.

117. Hurricane Katrina was, of course, an exception in causing massive damage, currently estimated at well over $125 billion, and close to more than 1800 deaths. By contrast, 2004's Hurricane Ivan caused $14 billion and 57 deaths and the Northridge earthquake caused 61 deaths and more than $20 billion in damage. *See* NATIONAL CLIMATIC DATA CENTER, *U.S. Billion Dollar Weather U.S. Disasters, 1980-2005*, http://www.ncdc.noaa.gov/oa/reports/billionz.html (last visited Jan. 27, 2007).

118. The 2004 hurricanes in Florida (Ivan, Charley, Frances and Jeanne) led to the occupation of 16,000 FEMA housing units. *See* Press Release, Federal Emergency Management Agency, Hurricane Ivan Recovery in the Panhandle Adds Up to $1.4 Billion (Sept. 9, 2005), *available at* http://www.fema.gov/news/newsrelease.fema?id=18831 (last visited Jan. 27. 2007).

119. BBC News, *1989: Earthquake Hits San Francisco*, http://news.bbc.co.uk/onthisday/hi/dates/stories/october/17/newsid_2491000/2491211.stm (last visited Jan. 27, 2007).

Monica freeway in the 1994 Northridge earthquake[120]), stories of families living in temporary trailers long after a disaster has occurred,[121] stories of good reconstruction jobs[122] and bad ones,[123] stories of fights with insurance companies who deny or delay claims,[124] and the list goes on and on. The point is that property damage keeps destructive disasters in the news long after they occur and, therefore, keeps their danger readily available to news consumers. Property damage helps explain why the Northridge earthquake, and the $20 billion in property damage that resulted, was reported much more heavily than the Chicago heat wave a year later - despite the fact that the Chicago heat wave killed almost thirteen times as many people. Moreover, in reporting property damage stories, even long after the event, the alarming visual images associated with hurricanes and earthquakes get repeated over and over again. These reporting patterns are consistent with risk perception research, which demonstrates that the extent of human exposure to any event is a more important factor in public perception of risk (as well as media coverage) than the number of casualties.[125] The availability heuristic suggests, as well, that these vivid images will cause the public to underestimate the risk of death by heat as compared with more dramatic natural disasters.

2. Government Response to Disasters

With one minor exception, the federal government provides no financial compensation for human casualties caused by a disaster. Instead, the extensive federal system of disaster relief, which is

120. UNITED STATES GEOLOGICAL SERVICES, HISTORIC EARTHQUAKES: NORTHRIDGE, CALIFORNIA, http://earthquake.usgs.gov/regional/states/events/1994_01_17.php (last visited Jan. 27, 2007).

121. Jonathan Weisman, *Critics Fear Trailer 'Ghettos'*, WASH. POST, Sept. 16, 2005, at A18, *available at* http://www.washingtonpost.com/wp-dyn/content/article/2005/09/15/AR2005091502159.html (last visited Jan. 14, 2007).

122. Peter Phillips, *Lessons for Post-Katrina Reconstruction: A High Road vs. Low-Road Recovery* (Economic Policy Institute, Briefing Paper #166, 2005) (describing the speed and competence with which the Santa Monica freeway was rebuilt following the 1994 Northridge earthquake).

123. *See* Associated Press, *Illegals Exploited in Katrina Cleanup, Study Says*, June 7, 2006, *available at* http://www.msnbc.msn.com/id/13178949/ (last visited Jan. 27, 2007) (describing bad working conditions among undocumented construction workers, including safety violations).

124. Becky Yerak, *Katrina Ruling Favors Allstate: No Class-Action Status for Mississippi Claims*, CHI. TRIB., Sept. 12, 2006, at 3 (describing court ruling filed by policyholders whose claims for hurricane damage have been denied by Allstate).

125. *See* Kasperson, Kasperson, Pidgeon & Slovic, *supra* note 103, at 18-19.

administered largely through FEMA, is predominately available only for property damage losses (including displacement) caused by declared major federal disasters.[126] Some assistance exists for medical problems stemming from disasters, but funds are not generally available to compensate survivors for the death of a loved one.[127]

The result is that almost no federal money is spent on the aftermath of heat waves, while extensive federal funds aid recovery from disasters that cause significant property damage. Indeed, the most significant heat waves in recent memory, the two Chicago heat waves of the 1990s and the 2006 California Central Valley heat wave, were not declared federal disasters despite the fact that the declaration of major federal disasters is almost commonplace. Over the last ten years, major federal disasters have ranged from a low of 44 in 1997 to a high of 75 in 1996.[128]

The fact that federal monies are available for disasters that cause property damage but not for disasters that cause only human death has, I suggest, significant effects on the degree to which we perceive heat waves as problematic, at least when compared with other disasters. The provision of federal monies means that public officials at the federal, state, and local levels have a large role to play in the aftermath of a physically destructive disaster, thus remaining involved in the issue long after it occurs. This involvement can take the form of ensuring that federal and other government and private funds reach their constituents. The attention and involvement of public officials is not limited, however, to remedying past harm. Where significant

---

126. Examples include Assistance to Individuals and Households, STAFFORD ACT, 42 U.S.C. §§ 5174-5188; unemployment assistance for those whose job loss is attributable to a major disaster, 42 U.S.C. §5177; residential loan assistance, 15 U.S.C. 636(b); numerous programs for states and localities that have been hard hit by a major disaster, see, e.g., Hazard Mitigation Grants, 42 U.S.C. §5172(a)(1)(A) and Community Disaster Loans, 42 U.S. C. §5121 *et. seq.* For a list of the various federal disaster programs see Mary Jordan, *Federal Disaster Recovery Programs: Brief Summaries*, CONGRESSIONAL RESEARCH SERVICE (Aug. 29, 2005 update), *available at* http://www.fas.org/sgp/crs/homesec/RL31734.pdf (last visited Jan. 27, 2007).

127. Exceptions for the surviving spouse or child of a public safety officer killed in the line of duty are codified in the Public Safety Officers' Benefits Program, 42 U.S.C. §3796, and the Public Safety Officers' Educational Assistance Program, 42 U.S.C. §3796(d).

128. For a listing of federally declared disasters by year and state, see http://www.fema.gov/news/disaster_totals_annual.fema (last visited Jan. 28, 2007). The total number of federally declared major disasters obviously varies year to year, but is virtually always in the double digits.

property damage occurs, policy makers frequently also focus on measures to prevent and mitigate future disasters of the same kind. Following the Northridge earthquake, for example, Congress passed a bill allowing federal highway funds to be used for the retrofitting of bridges to meet new earthquake safety standards. Following the Loma Prieta earthquake of 1989, the state of California allocated $80 million for retrofitting bridges based on what engineers learned from the collapse of the San Francisco Bay Bridge.[129] California also poured massive amounts of money into retrofitting unsafe public buildings. The aftermath of the 2005 Gulf Coast hurricanes has seen a huge influx of funding intended for the rebuilding of levees and extensive analysis of lessons learned from the failure of New Orleans' complex flood-control system.[130]

Another consequence of disasters that cause major property damage is the development of a constituency that lobbies for federal reconstruction funds; this constituency includes not just victims of a disaster, but also those who stand to benefit financially from the reconstruction efforts (providers of temporary structures, builders, etc.).[131] This constituency ensures that a large number of policy-makers and policy-influencers remain focused on certain types of disasters long after they hit. Heat waves produce no such focus and thus, again, fade much more quickly from the scene.

V.
HEAT WAVE MITIGATION

If the public generally underestimates the risk of heat wave casualties, and if climate scientists are correct in predicting an

129. *See* U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION, *Seismic Retrofit*, http://www.fhwa.dot.gov/cadiv/techapps/seismic.htm (last visited Jan. 28, 2007).

130. For an extensive government-funded analysis of the levee system, see R.B. SEED ET AL., INVESTIGATION OF THE PERFORMANCE OF THE NEW ORLEANS FLOOD PROTECTION SYSTEMS IN HURRICANE KATRINA ON AUGUST 29, 2005, vol. 1 (July 31, 2006), *available at* http://www.ce.berkeley.edu/~new_orleans/ (last visited Jan. 28, 2007).

131. The Army Corps of Engineers received over 6,000 phone calls from local and regional contractors in the weeks following Katrina. *See* Charlie Cray, *Disaster Profiteering*, 26 MULTINAT'L MONITOR, *available at* http://www.multinationalmonitor.org/mm2005/092005/cray.html#Charlie (last visited Jan. 28, 2007). For an account of the role lobbyists played in developing the Louisiana Katrina Reconstruction Act, see Alan C. Miller & Ken Silverstein, *A Long Road to Recovery: Lobbyists Advise Katrina Relief*, LOS ANGELES TIMES, Oct. 10, 2005, at A1.

increase in the frequency and intensity of heat waves over the course of the next century, heat-wave deaths will very likely increase – perhaps dramatically – without active intervention. Conservative modeling predicts an increase in heat-related mortality of 70% in the U.S by 2050.[132] Annual heat deaths will increase to well over five hundred a year, a figure that includes only those deaths actually identified as heat-related; many more – perhaps 2,500 per year – will die accelerated deaths from heart and respiratory diseases.

Unlike many potential global warming-induced catastrophes (stronger and more intense hurricanes, dramatic reductions in water supply, coastal flooding, and erosion), the capacity to adapt to increased episodes of intense heat should not require dramatic alterations in physical infrastructure or individual behavior. Instead, we already possess the means to mitigate the worst effects of increased heat waves. Yet, for the most part, we remain woefully ill-prepared. Responding to heat waves requires careful planning, increases in disaster planning funding, and incorporation of the latest scholarly research on heat warnings and risk perception. Moreover, some mitigation measures may require changes in legal doctrine, and increased federal funding for energy costs for low-income families. Other measures may require substantial investment in outdated infrastructure. Finally, more far reaching and profound changes in the design of urban environments could reduce heat-wave deaths dramatically while providing other environmental and quality of life improvements. Such changes, however, require a committed and sustained rethinking about urban planning and design.

A. *Heat Wave Emergency Plans*

Many large American cities at risk for heat waves lack a basic emergency plan for excess heat. In a survey of eighteen at-risk U.S. cities, Susan Bernard and Michael McGeehin found that a third of the surveyed cities lacked any plan. Of the ten cities that had stand-alone heat response plans, a third of those were "cursory."[133] Thus, about two thirds of cities had plans that were either ineffectual or non-existent.

Though the responsibility to prepare emergency plans for natural disasters lies with state and local jurisdictions, the federal

---

132. Kalkstein & Greene, *supra* note 3, at 90.
133. Bernard & McGeehin, *supra* note 8, at 1520.

government is involved in several significant ways. Importantly, the National Weather Service has a $700 million budget and provides extremely sophisticated weather forecasting that, among other things, helps states and localities mitigate the worst effects of extreme weather.[134] And, as of 2000, the federal government requires states, localities, and tribes to submit disaster mitigation plans to FEMA; if a jurisdiction does not have a plan it loses eligibility for post-disaster assistance.[135] All fifty states now have FEMA-approved "multi-hazard mitigation plans."[136] These multi-hazard plans are, as they sound, intended to address all of the natural hazards a particular jurisdiction may face – including heat.[137] In addition, FEMA provides some funding to states and localities to engage in pre-disaster mitigation planning through the competitive Pre-Disaster Mitigation Grant Program. The funding has varied fairly dramatically over the past several years, ranging from a high of $255 million in 2005 to a low of $50 million in 2006. The appropriation for 2007 is $100 million.[138] The vast majority of this money funds projects, such as earthquake retrofitting, rather than planning.[139]

Though federal efforts to promote pre-disaster planning are laudatory, the 2004 Bernard/McGeehin study demonstrates that many cities are clearly failing to adequately address heat emergencies. As of 2004, many were not addressing the issue at all, while others were doing so ineffectually through multi-hazard assessments. Still other cities had stand alone plans, but these plans were not prepared effectively. It is difficult to know exactly why so many cities have failed to engage in effective planning, though the factors that contribute to individuals

134. See NATIONAL OCEANIC ATMOSPHERIC ADMINISTRATION, FY 2007 BUDGET SUMMARY, at 4-48, *available at* http://www.corporateservices.noaa.gov/ ~nbo/ FY07_BlueBook/PDFs/FY07Final BlueBook_FINAL.pdf (last visited Jan. 28, 2007), for a description of the National Weather Service and its budget.

135. Disaster Mitigation Act of 2000, Pub. L. No. 106-390, 114 Stat. 1552 (2000).

136. *See* FEDERAL EMERGENCY MANAGEMENT AGENCY, *Approved Multi-Hazard Mitigation Plans*, http://www.fema.gov/plan/mitplanning/applans.shtm (last visited Jan. 27, 2007).

137. *See* FEDERAL EMERGENCY MANAGEMENT AGENCY, MULTI-JURISDICTIONAL MITIGATION PLANNING: STATE AND LOCAL PLANNING HOW-TO GUIDE NUMBER EIGHT (2006), at Ex. 5 (listing extreme heat among natural hazards to address), *available at* http://www.fema.gov/library/viewRecord.do?id=1905 (last visited Jan. 28, 2007).

138. *See* FEDERAL EMERGENCY MANAGEMENT AGENCY, *Pre-Disaster Mitigation Grant Program*, http://www.fema.gov/government/grant/pdm/index.shtm (last visited Jan. 28, 2007).

139. *See id.*

underestimating heat risk presumably influence city officials as well. City officials are not immune to the availability heuristic and other cognitive shortcuts that work to push the ill effects of high temperatures off the "radar screen."

Nevertheless, some jurisdictions, including Chicago and Philadelphia, do have emergency plans that seem to work well. Effective emergency plans need to address three separate issues: when to issue heat warnings, to whom to direct those warnings, and how to actually reach and persuade those at highest risk to heed heat warnings. I explore the second and third issues in combination.

1. When to Issue Heat Warnings

Though high temperatures would seem to provide an obvious answer to the question of when to issue heat warnings, advances in our understanding of which weather conditions are particularly dangerous have improved our capacity to predict when warnings should be issued. As previously detailed, locations differ in their residents' sensitivity to heat. Moreover, a combination of heat, humidity, lack of wind, and other factors can prove particularly deadly. The result is that localized warning systems, based on historical local daily mortality data coupled with complex weather data for time periods when mortality rates exceed normal averages, are more effective at mitigating the fatal effects of excess heat. The National Weather Service (NWS) has implemented these localized warning systems in sixteen cities across the country, and is in the process of expanding these systems to all metropolitan areas with populations exceeding 500,000.[140] Once the NWS systems are in place across the country, local jurisdictions should have the means to issue warnings for the most risky heat events. Ensuring that those most susceptible to excess heat actually hear and heed those warnings remains a significant challenge.

140. For a detailed description of these systems see Scott C. Sheridan & Laurence S. Kalkstein, *Progress in Heat Watch-Warning System Technology*, 85 BULL. AM. METEOROLOGICAL SOC'Y 1931 (2004); for a description of the National Weather Service efforts, see NOAA, *NOAA Heat/Health Watch Warning System Improving Forecasts and Warnings for Excessive Heat*, *available at* http://www.noaanews.noaa.gov/stories2005/s2366.htm (last visited Jan. 28, 2007).

2. Targeting the Warnings and Making them Effective

We know from extensive demographic research that the most likely victims of heat waves are the elderly, those who are socially isolated, those with physical and mental illness, and the poor.[141] The vulnerability of many potential heat-wave victims may also make them quite difficult to reach. The channels of communication used are thus extremely important in designing an effective heat warning system – as is the content of the warnings.

Effective systems require multiple layers of communication as well as extensive coordination among a variety of organizations and individuals. Scott Sheridan has studied how well senior citizens process information provided by cities that have heat warning systems in place.[142] Sheridan surveyed individuals 65 and older in four cities after heat emergencies had been declared. These cities sent out heat advisories to local media outlets and other organizations that have high contact with seniors. He found a remarkably high awareness of heat warnings, with awareness rates of between 83 and 91% in each city surveyed.[143] Virtually all respondents learned of the heat warnings from traditional media sources, with the vast majority hearing and seeing them on television. Several of Sheridan's findings, however, raise concerns about the effectiveness of heat warnings. Fewer than half of those surveyed reported changing their behavior in any way because of excess heat. Between half and a third (depending on the city) reported being concerned about cost in using air conditioning. A majority of respondents in every city but Philadelphia did not recall that the warnings advised them to seek out or remain in air-conditioned locales, including city-provided cooling centers. In addition, more than half of those surveyed believed the heat was either "not at all" or only "a little" dangerous to them. Only 15% believed excess heat was very dangerous to them.[144]

Sheridan's findings seem consistent with research about risk perception. Respondents understand when excess heat exists, but many do not view heat as personally problematic or dangerous. Cities use other mechanisms to reach individuals particularly at risk, mechanisms I will return to in a moment, but it does

141. *See* discussion *supra* Part II.C.
142. Sheridan, *supra* note 71, at 1.
143. *Id.* at 3.
144. *Id.* at 3, 6.

not appear that any city has relied on risk perception literature to generate more successful means of mass communication about the dangers of heat waves. Though my aim here is not to design warning strategies for urban areas about heat waves, I do suggest that those who design such strategies can use evidence about the availability heuristic and risk perception to make heat warnings more effective. For example, the availability heuristic suggests that warnings need to use graphic and dramatic images to trigger heightened responses.[145] Moreover, risk perception research suggests that individuals assess risks as higher when large numbers of victims are involved.[146] Thus, information about the numbers of victims and alarming images about heat stroke may help "bring home" the message that individuals should take precautions during heat waves.

Successful heat wave responses go beyond public announcements, and also include more intensive components designed to reach those who either have not heard the warnings or are not heeding them. Philadelphia, for example, has a large network of groups and individuals, educated about heat and the city's heat warning system, who help identify potentially vulnerable individuals. These groups and individuals help distribute information about extreme heat and appropriate responses to vulnerable individuals. During heat crises, Philadelphia runs a hotline that can provide nurses for those affected, as well as home visits.[147] Since the 1995 heat wave, Chicago has instituted an extensive program to make door-to-door visits during episodes of high heat to parts of the city with high percentages of senior citizens.[148] Cooling centers are available throughout the city, and at-risk individuals in the Extreme Weather Notification System receive automated phone calls during extreme heat giving them information and safety tips for dealing with excess temperatures.[149] Evidence suggests that implementing these heat warning systems pays off in reduced mortality. One study suggests that Philadelphia saved 117 lives between 1995 and 1998 by implementing an

145. *See supra* notes 100-110 and accompanying text.

146. *See* discussion *supra* Part IV.

147. *See* Sheridan, *supra* note 71, at 4.

148. *See* KLINENBERG, *supra* note 4, at 226-27.

149. *See* U.S. ENVTL. PROT. AGENCY, HEAT WAVE RESPONSE PROGRAMS, http://epa.gov/heatisland/about/heatresponseprograms.html (describing Philadelphia and Chicago programs).

effective heat warning system at a very low cost.[150] Eric Klinenberg recounts Chicago's successes in implementing an extensive system following the disastrous 1995 heat wave, successes that led to much lower mortality in the 1998 heat wave.[151]

The point in recounting these elements of successful plans is that cities can have a demonstrable and positive effect in reducing heat wave fatalities. The difficulty, of course, is generating more wide-spread adoption of such plans in other vulnerable cities and areas. The federal government clearly can play a role here. The National Weather Service has focused increasing attention on developing sophisticated heat warning systems and will soon implement these systems nationwide.[152] Moreover, researchers have assembled important historical data about mortality rates and heat for cities across the country.[153] The combination of data from these sources should make it relatively easy for FEMA to understand which cities in the country should have the sorts of comprehensive heat emergency plans currently in effect in Chicago and Philadelphia. Once high risk jurisdictions are identified, FEMA should require the development of heat emergency plans as part of the multi-hazard mitigation plan requirement.[154]

Once jurisdictions have such plans, implementing them becomes another obstacle. As the response to Katrina amply demonstrated, planning is one thing – carrying out that plan methodically and carefully is quite another.[155] We have likely made some progress, in the aftermath of Katrina and the September 11, 2001 collapse of the World Trade Center, in coordinating federal efforts with those of the states. The reorganization of federal emergency response by creating a Department of Homeland

150. *See* Kristie L. Ebi et al., 85 *Heat Watch/Warning Systems Save Lives*, BULL. AM. METEOROLOGICAL SOC'Y 1067 (2004).

151. KLINENBERG, *supra* note 4, at 225-29 (describing heat mitigation programs put into place after the 1995 heat wave and concluding that many lives were saved as a result).

152. *See* NOAA, *supra* note 140.

153. *See* Kalkstein & Greene, *supra* note 3.

154. *See* discussion *supra* notes 134-44 and accompanying text.

155. For a thorough account of the errors in disaster planning, preparation and response to Katrina, *see* U.S. HOUSE OF REPRESENTATIVES SELECT BIPARTISAN COMMITTEE TO INVESTIGATE THE PREPARATION FOR AND RESPONSE TO HURRICANE KATRINA, A FAILURE OF INITIATIVE: FINAL REPORT OF THE SELECT BIPARTISAN COMMITTEE TO INVESTIGATE THE PREPARATION FOR AND RESPONSE TO HURRICANE KATRINA, H.R. REP. NO. 000-000 (2006), *available at* http://katrina.house.gov/.

Security in 2002 included the implementation of a National Incident Management System to standardize and coordinate federal, state, and local responses. The post-Katrina environment has brought additional reforms, including recommendations that the federal government sometimes take the lead in responding to particularly overwhelming circumstances rather than assuming that states and localities have sufficient resources to respond until they communicate otherwise.[156]

Nevertheless, a coordinated, well-run response to a heat emergency, particularly an emergency of the magnitude of the 1995 Chicago heat wave, is complex. In addition to media advisories, at-risk cities need to make myriad services available, including cooling centers, information hot lines, additional ambulances (often from neighboring jurisdictions), outreach workers (who can contact at-risk individuals), and transportation to cooling centers for seniors. Cities may need to target such resources at the poorest and most isolated neighborhoods, like the North Lawndale neighborhood that fared especially badly in the 1995 Chicago heat wave.[157] Strong emergency responses in heat waves also include careful monitoring of emergency rooms and nursing homes, coordination with power companies to persuade them not to disconnect service for unpaid bills during the emergency, and contact with senior organizations to enlist their assistance in providing warnings.[158] Again, part of the answer may lie in FEMA's leadership in requiring comprehensive emergency plans. Preparedness also clearly requires leadership by states and localities as they will inevitably lead any heat emergency efforts.

B. *The Importance of Air Conditioning*

It is difficult to understate how important the provision of air conditioning is to reducing heat wave casualties: staying cool in the first instance, and reducing body temperature once it has risen, are the most effective ways to remain safe during excess

---

156. For an overview of the national response system, see THE WHITE HOUSE, HURRICANE KATRINA: LESSONS LEARNED, CHAPTER TWO (NATIONAL PREPAREDNESS – A PRIMER) (2006), *available at* http://www.whitehouse.gov/reports/katrina-lessons-learned/. For a thoughtful and interesting textbook on Katrina specifically and natural disasters more generally, see DANIEL A. FARBER & JIM CHEN, DISASTERS AND THE LAW: KATRINA AND BEYOND (2006).

157. *See* discussion *supra* Part II.D.2.

158. *See* KLINENBERG, *supra* note 4, at 225-29, for a description of Chicago's response to the 1999 heat wave.

heat. Air conditioning provision can take several forms and raises important issues that may intensify if heat wave incidents increase as a result of climate change. Of course, absent major changes, emissions from the generation of energy used to power air-conditioning – contribute to climate change.[159] The question of how to reduce greenhouse gas emissions from energy generation is obviously one of the central challenges facing policymakers, and is beyond the scope of my analysis here. More immediately, however, strong energy efficiency standards for new air conditioners can at least offset some of the increased emissions at relatively low cost, as I detail below.

1. Cooling Centers

The most immediate and short-term way to provide air conditioning is to establish cooling centers in high risk areas during a heat wave crisis. Philadelphia and Chicago have both done so as part of their comprehensive heat wave emergency plans. While cooling centers can provide relief for some, they are likely to be of limited usefulness for infirm and isolated individuals unless emergency workers can reach them. A longer term and more comprehensive strategy is to expand air-conditioning availability and usage.

2. Availability

Air conditioning is currently much more available, not surprisingly, in the hottest parts of the country; more than 90% of households in the South Atlantic part of the U.S. have either central air or individual room units compared with only 59% in the Northeast. Air-conditioning availability has grown dramatically over the course of the last several decades and may reach close to complete coverage in new residential structures over the next two decades. But older housing in low-income areas in the cities most prone to heat waves (those cities with the widest temperature variations), is likely to remain without air conditioning absent government intervention. If heat waves indeed increase

159. Some of the predicted increase in air-conditioning use is likely to be offset by decreases in energy consumption for heating, a much larger source of residential energy usage than cooling. *See* Richard C. Diamond, *An Overview of the U.S. Building Stock*, *in* INDOOR AIR QUALITY HANDBOOK (2001). Nevertheless the predicted increases in energy usage to cool are likely to outweigh by a significant degree decreases in energy usage for heat. *See* Anthony D. Amato et al., *Regional Energy Demand Responses to Climate Change: Methodology and Application to the Commonwealth of Massachusetts*, 71 SPRINGER 175, 193 (2005).

both in frequency and intensity, at least three potential policy responses could increase air-conditioning access among the most vulnerable city residents.

a. *Air Conditioning Required*

The International Residential Code (IRC) is a model housing code used in one form or another by numerous states and cities around the country to ensure basic minimum standards for residential rental housing.[160] The IRC includes a provision to ensure a safe indoor thermal environment that reads as follows: "[e]very dwelling unit shall be provided with heating and cooling facilities capable of maintaining room temperatures between 70° and 90° . . . ."[161] Many cities around the country, however, drop the reference to cooling facilities and to a maximum temperature and instead require only the maintenance of *minimum* temperatures, typically somewhere between 64 and 70 degrees.[162] Very few cities, including extremely hot cities like Las Vegas and Palm Springs, require landlords to maintain *maximum* temperatures, though Phoenix, Philadelphia, and Tempe, Arizona are exceptions in requiring air conditioning.[163] A requirement that rental housing owners provide the means to maintain maximum temperatures could ensure that the infrastructure is in place to avoid massive heat wave casualties during extreme heat. Ensuring that residents actually use air conditioning, however, remains dependent on educating those at risk and providing energy funding for those who cannot afford their bills.

160. *See* International Code Council, http://www.iccsafe.org/news/about/ ("Most U.S. cities, counties and states that adopt codes choose the International Codes developed by the International Code Council.").

161. *See* International Residential Code §R303.8 (2003).

162. *See, e.g.*, MASS. STATE SANITARY CODE § 410.200 (2005) (requiring heating in every habitable room and requiring minimum temperature of 68 degrees during waking hours and 64 degrees from 11 p.m. to 7:00 a.m. unless a tenant has signed a lease agreeing to pay for fuel).

163. *See* PHOENIX, ARIZ., MUNICIPAL BUILDING CODE §1204 ("Interior spaces intended for human occupancy shall be provided with active or passive space-heating/cooling systems capable of maintaining room temperatures between 70°F (21° C) and 90°F (50° C) at a point 3 feet (914 mm) above the floor"); *See also* TEMPE, ARIZ., RENTAL HOUSING CODE §21-34 (c) ("Every rental housing unit shall have cooling, under the tenant's control, capable of safely cooling all habitable rooms, bathrooms and flush toilet rooms located therein to a temperature no greater than eighty-eight degrees (88°) Fahrenheit, if cooled by evaporative cooling, or eighty-two degrees (82°) Fahrenheit, if cooled by air conditioning.").

b. *Funding LIHEAP*

Having access to air conditioning is one thing; having the resources to use it is another. In the face of rapidly escalating energy prices, researchers estimate that households below the poverty line spent approximately 25% of their income on energy bills in 2006, yet consumed significantly less energy per capita than their richer counterparts.[164] The federal government, through the Low Income Home Energy Assistance Program (LIHEAP), does subsidize the energy needs of low-income households by providing funding to states. For the 2006 fiscal year, Congress allocated a record amount to LIHEAP, $3 billion in regular and emergency funding, in response to rising energy prices.[165] Many states further supplement LIHEAP funding through, for example, utility rate reductions funded by utility surcharges – accounting for an additional $2.3 billion in subsidies.[166] Nevertheless, the amount allocated for low-income subsidies is far lower than the estimated $60 billion low-income households spent on utility bills during 2006.[167] The average LIHEAP beneficiary receives just over $300 to cover utility expenses, less than 15% of the average annual utility bill for low-income households.[168] Moreover, Congress allocated a smaller LIHEAP allocation for the 2007 fiscal year – just over $0.5 billion in combined regular and emergency funding.[169]

In addition to the limitations of federal aid, many states provide assistance only for heating. Slightly fewer than half of the states provide cooling assistance in some manner, which may include assistance with bill payment, purchase of a fan or air condi-

---

164. Meg Power, *Low-Income Consumers' Energy Bills and Their Impact in 2006*, ECONOMIC OPPORTUNITY STUDIES 1 (2005), *available at* http://www.opportunitystudies.org/repository/File/weatherization/energy-ills-and-burden.pdf (last visited Jan. 30, 2007).

165. *See* U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, LIHEAP CLEARINGHOUSE, LOW-INCOME ENERGY PROGRAMS FUNDING HISTORY 1977-2006, *available at* http://www.liheap.ncat.org/Funding/lhhist.htm (last visited Jan. 30, 2007).

166. For a state-by-state breakdown of LIHEAP state supplements in 2005 by category, see U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, LIHEAP CLEARINGHOUSE, 2005 STATE BY STATE SUPPLEMENTS TO ENERGY ASSISTANCE AND ENERGY EFFICIENCY, *available at* http://liheap.ncat.org/Supplements/2005/supplement05.htm (last visited Jan. 30, 2007).

167. Power, *supra* note 164, at 6.

168. *Id.* at 5.

169. U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, LIHEAP CLEARINGHOUSE, LIHEAP FUNDING, *available at* http://liheap.ncat.org/Funding/funding.htm (last visited Jan. 30, 2008).

tioner, or crisis payments to prevent utility shutoffs. Many states, including states at high risk for heat-related deaths like Pennsylvania and New York, provide no cooling assistance.[170]

The expense of air-conditioning expenditures is significant enough that in Sheridan's survey of seniors exposed to heat warnings in four North American cities, between a third and a half (depending on the city of residence) considered the cost of air conditioning when deciding whether to use it during periods of high heat.[171]

An obvious solution to the high cost of air conditioning to low-income households is to increase funding for LIHEAP, or to – at a minimum – expand its coverage to include the provision of air-conditioning funds in high-risk states. Alternatively, cooling funds could be limited to days on which National Weather System heat warning are issued.[172] The availability of such funds could be announced as part of more general heat warnings issued by cities.

C. *Larger Structural Changes*

The heat wave mitigation efforts I have described above are relatively straightforward fixes that are largely reactive policies designed to respond to a particular type of extreme weather event. Much larger structural issues also affect our capacity to reduce the most negative consequences of excess heat. In-depth analysis of these issues is beyond the scope of this article, but I briefly consider them because of their obvious import.

1. Energy Efficiency and Supply

In any major episode of prolonged heat, whether the affected region's electricity system can handle surges in demand for power is of pressing concern. For example, during Chicago's 1995 heat wave, thousands of customers lost power for crucial periods of time;[173] during the summer of 2006, 500,000 St. Louis residents lost power for several days due to thunderstorms; and

---

170. *See* U.S. Dept. Health & Hum. Serv., LIHEAP Clearinghouse, Percent LIHEAP Funds By Program Component, *available at* http:// www.liheap.ncat. org/tables/FY2006/Components06.htm, for a description of how LIHEAP program funds are disbursed by state (last visited Jan. 30, 2007).

171. Sheridan, *supra* note 71, at 7. The survey does not appear to include income data.

172. *See* discussion *supra* note 140.

173. Klinenberg, *supra* note 4, at 3.

100,000 residents of Queens were without electricity during the same period, 50,000 of them for more than a week.[174] The causes of these episodes varied from excess demand for electricity to weaknesses in electricity distribution systems, thus calling for varied solutions. As temperatures continue to rise, the problems of high demand during particularly intense periods of heat will arise more frequently. Thus, issues of capacity and infrastructure capability must be addressed or the risk of increased deaths during intense heat will climb.[175] In addition, of course, the provision of additional electricity generation will need to take into account increased carbon emissions that are contributing to climate change in the first instance.

2. Energy Efficiency

Improving appliance energy efficiency, including the efficiency of central air-conditioning units, has been a federal goal since the passage of the Energy Policy and Conservation Act (EPCA) in the early 1970s.[176] The general benefits of such standards are clear: tremendous household savings in energy costs, lower demand for energy production, lower carbon emissions from reduced energy use, and less stress on energy systems during peak periods of demand.[177] The availability of highly efficient air conditioners during periods of intense heat has immediate benefits, including placing less stress on overtaxed electricity systems and cooling household dwellings at much cheaper prices.

The story of establishing appliance efficiency standards over the past thirty years has been a mixed one, with delays, statutory amendments, and lawsuits preceding significant federal action.[178]

---

174. James T. Gallagher, *The Power Outages in the Consolidated Edison Service Territory: Written Testimony Before the N.Y.C. Council Comm. on Consumer Aff.*, at 1 (Aug. 22, 2006), *available at* http://www.dps.state.ny.us/06E0894/06E0894_Testimony-CityCouncilCommitteeonConsumerAffairs.pdf (last visited Jan. 30, 2007).

175. For an overview of the adequacy of the power system over the next decade, see NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL, 2006 LONG-TERM RELIABILITY ASSESSMENT: THE RELIABILITY OF THE BULK POWER SYSTEMS IN NORTH AMERICA (Oct. 2006) (projecting declining electric capacity margins over the next ten years).

176. NRDC v. Abraham, 355 F.3d 179, 185 (2004) (discussing legislative history of EPCA).

177. *See, e.g.*, AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY, APPLIANCE AND EQUIPMENT EFFICIENCY STANDARDS: ONE OF AMERICA'S MOST EFFECTIVE ENERGY-SAVING POLICIES, http://www.aceee.org/energy/applstnd.htm (last visited Jan. 27, 2007).

178. In 1978, Congress gave up on a program to encourage manufacturers to voluntarily improve appliance standards and mandated that the Department of Energy

Additionally, the battle over seemingly mundane and technical standards, such as whether to adopt what are known as "SEER 12" or "SEER 13" efficiency requirements for central air-conditioning units, has enormous consequences. For example, the Clinton Administration adopted a SEER 13 standard, an increase from the existing SEER 10 standard, to take effect for all new air-conditioning equipment as of January 2006. In 2001, the Bush administration announced it was rolling back the standard to SEER 12, despite the position of its own Environmental Protection Agency (EPA) that the rollback was based on a Department of Energy analysis that both overstated the costs of the SEER 13 standard and underestimated the resulting savings.[179] The difference between two standards is huge: the SEER 13 standard will reduce energy usage at a rate equivalent to the annual energy use of 26 million U.S. households (4.2 quads of energy) over twenty five years, versus only a three quad reduction under the SEER 12 standard. Further, the higher SEER standard will reduce twenty-five more metric tons of smog-forming nitrous oxides and carbon than the SEER 12 standard.[180] The Bush Administration's actions were overturned by the Second Circuit in *NRDC v. Abraham*, however, and the higher SEER 13 standard took effect January 1, 2007.[181]

The purpose of recounting the battles of appliance standards is to stress that continuing efforts to improve energy efficiency for air conditioners, as well as for other high energy usage appliances, will have significant consequences for how we fare during periods of intense heat. Our systems for delivering energy will fare better with less stress on them, and consumers will both use less energy and save money from higher efficiency appliances.

---

set standards for 13 products. The 1978 Act also preempted states from setting their own standards for these products. For an overview of the events leading to the passage of the National Energy Policy Conservation Act in 1978, see Julia Richardson & Robert Nordhaus, *The National Energy Act of 1978*, 10 NAT. RESOURCES & ENV'T. 62 (1995) and *NRDC v. Abraham*, 355 F.3d at 184-88.

179. Environmental and Energy Study Institute, *Air Conditioner Efficiency Standards: SEER 13 vs. SEER 12*, http://www.eesi.org/publications/Fact%20Sheets/ac-factsheet.htm (last visited Jan. 28, 2007).

180. *Id.*

181. *NRDC*, 355 F.3d at 1855; *see also* 62 FED. REG. 50121-50150 (Final Rule Regarding Energy Conservation Standards for Room Air Conditioners).

3. Reducing the Urban Heat Island Effect

A more structural shift is required to mitigate the worst consequences of excess heat by reducing what scientists label the "urban heat island effect." This effect, the result of lower vegetation levels, higher amounts of "hardscape," heat from buildings and vehicles, and reduced air flow between tall buildings (as well as other physical alternations to the natural environment), leads to temperatures in urban areas as high as 10 °F greater than neighboring rural areas.[182] These temperature differences are largest at night, when cooler air results in much faster temperature drops in rural areas than in built up cities.[183] During periods of extremely high heat these differences can be life-threatening.

Several strategies are under way to reduce this effect. Sometimes these strategies are directly designed to minimize risk during heat waves and sometimes they are part of a larger project to improve the quality of life in cities, reduce energy, and improve air quality. Such efforts include installing "cool" roofs on residential and commercial city buildings, increasing city vegetation and using lighter and more porous paving materials. For example, the federal government led a program to reduce the urban heat island effect from 1998-2003 by providing pilot funding and information to several cities. Otherwise, however, the federal government plays only an informational role – making materials available on the EPA Web site.[184] Leadership in reducing the urban heat island effect has instead come from several cities. Philadelphia, for example, has a "Cool Homes" initiative to provide assistance in coating roofs with inexpensive reflective surfaces capable of reducing indoor temperatures on the top floors of buildings by five degrees.[185] Chicago has more famously instituted a green roof program to encourage the building of gardens on roof tops and has provided grant money to assist residential

182. *See* U.S. ENVTL PROT. AGENCY, HEAT ISLAND EFFECT, http://www.epa.gov/heatislands/about/index.html (last visited Jan. 28, 2007).

183. *See* IAUC TEACHING RESOURCES, THE URBAN CANOPY LAYER HEAT ISLAND 15, *available at* http://www.epa.gov/heatislands/resources/pdf/HeatIslandTeachingResource.pdf.

184. *See* U.S. ENVTL. PROT. AGENCY, HEAT ISLAND EFFECT, http://www.epa.gov/heatislands/ (last visited Jan. 28, 2007).

185. *See* Laurence S. Kalkstein & Scott C. Sheridan, *The Impact of Heat Island Reduction Strategies on Health-Debilitating Oppressive Air Masses in Urban Areas*, REPORT TO THE U.S. EPA HEAT ISLAND REDUCTION INITIATIVE 1 (2003); *see also* U.S. ENVTL. PROT. AGENCY, HEAT ISLAND EFFECT: COMMUNITY ACTIONS, http://www.epa.gov/heatisland/strategies/community.html (last visited Jan. 28, 2007).

and small commercial buildings in converting their rooftops.[186] Los Angeles just announced a "Million Trees LA" project, designed to plant a million trees over the next several years to "provide shade and save on energy costs, clean the air and help reduce the greenhouse gases that cause global warming, capture polluted urban runoff, improve water quality, and add beauty to our neighborhoods."[187]

On a much larger scale, for the past thirty years, city planning in Stuttgart, Germany has taken air circulation patterns into account when reviewing and approving development.[188] Though much of this effort has been aimed at improving air quality, an important benefit is drawing into the city cooler, fresher air that mitigates the urban heat island effect. The city's efforts have increasingly drawn the attention of U.S. cities and the federal EPA.[189]

To date, however, U.S. efforts to reduce urban heat are small-scale in nature. Only a few cities are making such investments and, for the most part, those investments are relatively modest. More meaningful change would require significant alteration in planning, changes in building codes to require green roofs and other heat-reducing technologies, and much larger public investments in preserving and increasing open space and generally greening urban environments. Moreover, the efficacy of various heat island-reducing measures varies in complicated ways across U.S. cities depending upon the particular types of heat events they experience. In an EPA-commissioned study of four cities around the U.S., Kalkstein and Sheridan found that increasing reflective roofs and vegetation would have quite different results on a regional basis: in Detroit and New Orleans these measures would have almost no effect on heat-related mortality, Los Angeles would experience significant improvements in mortality

---

186. *See* City of Chicago Department of Environment Website, *Green Roof Grant Program 2006 for Residential and Small Commercial Buildings*, http:// egov.cityofchicago. org/webportal/COCWebPortal/COC_EDITORIAL/ Winning_Applications_Summary_2006.pdf.

187. http://www.milliontreesla.org/mtabout.htm (last visited Jan. 28 2007). In doing so Los Angeles will largely replace its famous palm trees which, while emblematic of the city, provide almost no shade and create hazards when their large fronds blow off in the winter winds. *See* Jennifer Steinhauer, *City Says Its Urban Jungle Has Little Room for Palms*, N.Y. TIMES, Nov. 25, 2006.

188. Anne Whiston Spirn, *The Role of Natural Processes in the Design of Cities*, 451 THE ANNALS OF THE AM. ACAD. OF POL. & SOC. SCI. 99-100 (1980).

189. http://www.epa.gov/innovation/international/best.htm (last visited Jan. 30, 2007).

rates, and Philadelphia would experience moderate improvements.[190] The larger point is that we are only beginning to understand the relationship between higher temperatures in urban areas and the urban heat island effect, and we are only taking tiny steps to lower city heat.

VI.
CONCLUSION

If climate change projections are accurate, the next forty years may bring annual death rates from heat waves in the United States in excess of the death toll from Hurricane Katrina. Yet, the already high heat related death toll remains largely invisible to the general public and many policy makers. Complex reasons account for this lack of visibility, including the nature of the victims, the lack of property damage heat waves create, and cognitive mechanisms that cause the lay public and policymakers to underestimate the risks of excess heat and, in turn, to fail to take steps to mitigate its worst effects. Nevertheless, the mechanisms to avoid high numbers of heat-wave deaths exist. The central question is whether vulnerable jurisdictions will act before a calamitous heat wave occurs. Some promising signs exist, including the National Weather Service's extension of its localized heat warning system to all cities with populations greater than 500,000,[191] as well as sophisticated heat response plans in Chicago and Philadelphia.[192] But, much discouraging evidence exists as well, including a remarkable lack of readiness in many vulnerable cities. The unfortunate odds are that disaster will strike in these unprepared cities, an outcome all the more troubling because it is both predictable and avoidable.

190. Kalkstein & Sheridan, *supra* note 185, at 23.
191. *See supra* note 140 and accompanying text.
192. *See supra* note 147-48 and accompanying text.