
A Publication of NCAR's Societal Impacts Program (SIP) Volume 1, Number 2, January 10, 2007

# Our Science is Only as Good as Society's Ability to Use It

**by William H. Hooke***

The International Council for Science (ICSU), a global non-governmental organization that comprises more than 100 national scientific bodies and 29 international scientific unions, submits that the greatest challenge facing us, as 21st-century scientists, is the widening gap between the advance of science and society's ability to use it. (ICSU Report 2006). This broad notion underpins much of ICSU activity, which includes planning and coordinating inter-disciplinary research; actively advocating freedom in the conduct of science; acting as a focal point for the exchange of ideas; and supporting more than 600 scientific conferences, congresses, and symposia each year. A recently constituted ICSU panel on natural and human-induced environmental disasters, for example, is charged with gaining a better grasp on why, despite advances in scientific understanding of the natural and social causes for disasters, disaster losses continue to mount (CSPR Report 2005).

If the gap between science and society's ability to use it is indeed widening, meteorologists in general, and researchers in particular, ought to be concerned because this challenge threatens the privilege we've enjoyed for decades—the ability to pursue curiosity-driven research relatively unfettered. In addition, this research is handsomely supported by a taxpaying public on the premise that the benefits will more than exceed the costs, and soon. We also ought to care on purely humanitarian grounds: A range of social ills—poverty, environmental despoliation, and threats to public health and safety, among others—desperately call for help from meteorology, broadly construed.

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Many meteorologists would say that we *have* responded over the years. NOAA, NASA, and NSF have all invested in applied research, systems development, technology transfer, rapid prototyping, decision support tools, community-based research, and extension services, in an effort to accelerate the societal benefits from science and technology. A new breed of experts, known variously as bridgers, information brokers, translators, or interpreters, is emerging to facilitate this work. Additionally, cost–benefit analyses and other socioeconomic research can help prioritize science and technology based on likely societal utility.

Such efforts are necessary, but are they *sufficient*? So far, the work has proven demanding, widespread support has been minimal, and improvements have been uneven and incremental at best. Moreover, the benefits of science (although they can be characterized) are not fundamental constants. Instead, they vary considerably, depending on the prevailing policy framework at all levels of government. Consider, for example, the differences between U.S. electricity deregulation and water resource management. Electricity deregulation and the growth of regional and national power grids has reduced margin (the surplus-generating capacity of private utilities, which had previously been largely idle).

*(continued on page 8)*

*Dozens of Boulder, Colo., drivers fight deteriorating rush hour conditions during December's first blizzard. (Photo by Ilan Kelman.)*

## In This Issue

# Urban Cloud-to-Ground Lightning Enhancement in Atlanta, Georgia, and its Relevance to Urban Weather Hazards

**by J. Anthony Stallins[1] and Mace L. Bentley[2]**

Global-scale anthropogenic climate change affects the frequency, seasonality, and intensity of weather-related hazards, which have long-term social, political, and economic consequences. Smaller-scale anthropogenic climate modification through rapid urbanization and the resulting hazards are also of importance. Although it has long been recognized that urbanization affects the thunderstorm climatology of cities (see review in Changnon 2001), the effects on lightning flash production have only recently been examined. Areas downwind of large city centers may exhibit increases in lightning because of an urban heat island (UHI) enhancement of thunderstorm frequency (Wescott 1995; Areitio et al. 2001; Steiger et al. 2002). Subsequent urban lightning hazards, as with weather hazards in general, reflect an interaction between the physical environment and the underlying demographic template (White and Hass 1975; Mileti 1999). Given that no two UHIs are the same, urban lighting hazards also reflect the locally contingent intersection of demographic trends, the regional tracks of UHI-modified thunderstorms, physiographic features, and land-use types.

Evidence suggests that, in the United States, lightning ranks above thunderstorm winds, heat waves, and droughts in terms of dollar amounts of property damage, costing insurers and homeowners an estimated $332 million each year (Holle et al.1996). In an investigation of weather-related insured property losses for Georgia, we found that lightning dollar losses were second only to those from wind damage over the interval from 1996 to 2000 (Stallins 2002). Half of all weather claims (53%) were the result of lightning. After accounting for the market share of the company that provided these data, lightning property damage may range as high as $110 million per year for Georgia alone, calling into question previous estimates of lightning damage for the United States.

*Cloud-to-ground lightning strikes behind a house near St. Francis, Kansas, in a storm that had previously produced several tornadoes. (Photo by Gregory Thompson; http://www.inclouds.com.)*

***Evidence suggests that, in the United States, lightning ranks above thunderstorm winds, heat waves, and droughts in terms of dollar amounts of property damage, costing insurers and homeowners an estimated $332 million each year***

Eighty percent of the U.S. population now lives in cities. Migration and subsequent urbanization have increased the amount of urbanized land cover for the conterminous United States to 112,610 km$^2$ (approximately the area of Ohio; Elvidge et al. 2004). These urban areas have dense public and private electrical infrastructures. Large amounts of capital are required to engineer these extensive power systems to specifications that resist lightning damage, as well as to build and maintain the systems. Homes and businesses that host computers, appliances, and other electrically sensitive equipment are distributed throughout these networks. Within densely built urban and suburban regions, lightning has the potential to overwhelm public fire safety personnel with emergency calls. For example, in Gwinnett County, Georgia, fire department staff responded to 97 calls related to lightning strikes during a 3.5-hour thunderstorm in 2000 (September 20: NOAA Storm Report). Overall costs for the replacement, upkeep, and protection of electrical infrastructure and consumer products, as well as the added costs for public safety, are likely underestimated. These costs may also be a largely unaccounted-for factor in the regional economy of a thunderstorm-prone urban region such as the southeastern United States (Stallins 2004).

We have established an urban lightning climatology for the region surrounding Atlanta, Georgia (Stallins et al. 2006). Lightning enhancement around Atlanta is on the order of 6–8 flashes km$^{-2}$ yr$^{-1}$, which is as high as that observed along the lightning-active Georgia coast over the period from 1992 to 2003. A prominent lightning hotspot—as defined by the density of cloud-to-ground lightning and the number of lightning

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# From the Director

***Integrating Societal Impacts Research and Applications with Weather***
**by Jeffrey K. Lazo***

***Are societal impacts research and applications becoming more integrated into the weather community?*** Although I've been in the business of weather and societal impacts for just a couple of years, I feel qualified to say—a "qualified"—yes! A number of activities, both planned and ongoing, are examining a variety of approaches to include or integrate societal impacts research and applications into the weather community. Consider, for example, the following:

The THORPEX Program of the World Meteorological Organization (WMO) has the stated purpose of "Accelerating improvements in the accuracy of one-day to two-week high-impact weather forecasts for the benefit of society, the economy and the environment" (http://www.wmo.ch/thorpex/). One of the four primary research foci of THORPEX is Societal and Economic Research and Applications with the following goals: "i) evaluate the net economic benefits of THORPEX improvements in weather forecasting; ii) assess and improve the content, distribution, communication, recognition, and responses to weather forecast systems and information; and iii) assist with product development and the transfer of tools and knowledge, especially to developing countries." (International Science Plan 2004, p. 44).

This March in Madrid, the WMO will host the International Conference on Secure and Sustainable Living: Social and Economic Benefits of Weather, Climate and Water Services. The conference will be an "occasion for representatives of various sectors of society to describe how the environment impacts them; how weather, climate and water information helps them make decisions and reduce risks; and to outline what changes would be needed to improve decision-making" (http://www.wmo.ch/Madrid07/).

The Collaborative Adaptive Sensing of the Atmosphere (CASA) program includes the *End User Integration* team to study "social, policy, behavioral, and technical interface issues around the use of DCAS systems in weather impacted decision making and response." This effort includes projects on Decision Sciences, Simulations for End Users, Vulnerability Analysis, End User Policy Development, and Emergency Manager In-Depth Interviews (http://www.casa.umass.edu/).

The 2007 American Meteorological Society Annual Meetings will include the Second Symposium on Policy and Socio-Economic Research to "provide a forum where
(i) researchers can share their findings and report on recent progress
(ii) policy makers can dialog with researchers about areas that merit further analysis and why
(iii) and researchers can dialog with each other and with federal agency officials and others."

This year's AMS program includes at least 3 panel discussions, 3 joint sessions, 2 poster sessions, and 15 papers in two policy sessions. For details, visit (http://www.ametsoc.org/meet/annual/call.html#research).

Even with these activities and others I haven't mentioned (or don't know about), you may remember that my "Yes!" answer was qualified. I don't think we can say yet that societal impacts research and applications are fully or adequately integrated into the weather community. Perhaps I or others can say more about how to achieve better integration in future issues of *Weather and Society Watch.* Please note that this is a thinly veiled invitation for editorial comments for future editions!

If you know of other activities that should be included in this list, please let us know, and we'll include them in future issues of *Weather and Society Watch*.

Oh . . . and a belated Happy New Year!

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### Reference

International Science Plan, November 2004: THORPEX International Science Steering Committee. Version 3, p. 44. [Online at http://www.wmo.ch/thorpex/pdf/executive%20summary.pdf].

*A commuter bikes through deep snow near one of NCAR's Boulder facilities during the first of December's blizzards, which dumped over two feet of snow in less than 24 hours. (Photo by Ilan Kelman.)*

# The Fujita Scale and Societal Vulnerability to Tornadoes

**by Daniel Sutter[1]**

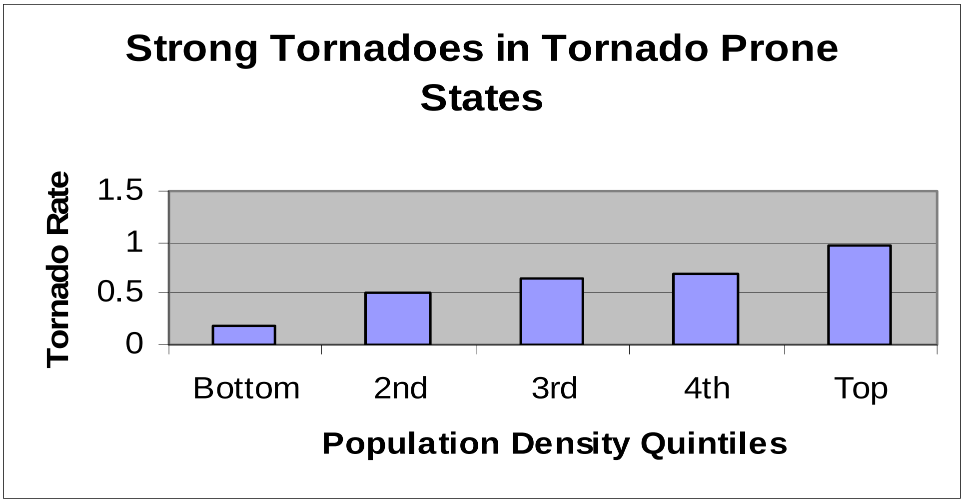
The National Weather Service (NWS) recently introduced an Enhanced Fujita Scale for rating tornadoes and tornado damage. The modifications to the familiar F-scale ratings were the result of a multiyear effort of a commission comprising engineers, meteorologists, and other scientists. The enhancement involves a detailed set of 28 damage indicators to be used to grade tornado damage. According to the commission's report,

*[T]he limitations of the [Fujita] scale are well known to the users. The primary limitations are a lack of damage indicators, no account of construction quality and variability and no definitive correlations between damage and wind speed. These limitations have led to inconsistent rating of tornadoes and in some cases an overestimate of tornado wind speeds (Wind Science and Engineering Center 2006).*

On the enhanced scale, tornadoes will still be rated from zero to five, but the enhancements are designed to ensure more accuracy and consistency in ratings.

Reducing potential errors in rating tornadoes is a worthwhile goal, because rating errors or inconsistencies can lead to mistaken inferences about the impacts of tornadoes on society. Damage-rating inconsistencies by NWS personnel across the country could lead to apparent differences in tornado climatology, which in reality would be nothing more than regional differences in assessing damage. Underrating tornadoes in some parts of the country might lead researchers to investigate why local tornadoes cause more death and destruction than comparable tornadoes elsewhere.

The Fujita scale enhancements, however, do not address perhaps the biggest potential weakness in using tornado records to evaluate future societal vulnerability. Ultimately, the Fujita scale is a damage scale, as has been noted for years (Doswell and Burgess 1988), but social scientists must use it as an intensity scale in research because no other measure of tornado intensity exists. In my research with Kevin Simmons on the




*Tornadoes rated F3 or stronger per year per 10,000 $mi^2$ of land area in counties in ten tornado-prone states: Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas. Counties are ranked by average population density from 1950 to 2000. Source: Department of Economics and Finance, University of Texas - Pan American*

determinants of tornado casualties (2005a, b), we needed to control for tornado characteristics such as time of day, path length, and most importantly, strength, in order to discern how casualties are affected by societal factors such as population density or warning issuance. There is no alternative to using the F-scale rating of the tornado as a control variable, and overall the F-scale rating has always worked exceedingly well in our regression analysis (meaning that it is always a highly statistically significant determinant of fatalities or injuries).

Damage, the F-scale rating of a tornado, and its intensity "rating" can diverge. A tornado that strikes a rural area—farmland or forests—will not damage buildings, and a tornado that does not damage any permanent structures is rarely rated above F2. A tornado capable of causing F4 or F5 damage will likely be rated F1 or F2 if it strikes a rural county and misses any of the structures in the area. In essence the NWS rating of a tornado on the F-scale is a *minimum* rating—the minimum level of damage the tornado actually did, not the potential for damage or casualties if the tornado had struck a city or town.

How large might this bias in tornado climatology be? If the bias is substantial, we should observe its

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impact in historical tornado records. To investigate this, I used the count of tornadoes rated F3 or stronger to strike each county in ten tornado-prone states for the years 1950 to 1999, as reported in the Storm Prediction Center's (SPC) tornado archive [1]. I then calculated an annual rate of F3 or stronger tornadoes and the number of storms per year per 10,000 square miles of county land area, which is a common measure of a tornado rate. I also calculated the mean population density for each county during the period, or the mean of the county population in the six decennial censuses between 1950 and 2000 divided by county land area. I ranked the 1,001 counties in the ten states by average population density and calculated the mean of the tornado rate for the counties in each quintile. Figure 1 displays the results.

Population density significantly affects the number of powerful tornadoes in a county, with the rate rising between each quintile (when moving from the least to most densely populated counties). The mean rate for the least populous quintile, 0.20 storms per year, is less than half the mean rate for the next quintile (0.51) and about one-fifth the mean rate for the most populous quintile (0.96). The climatologies of the counties in these tornado-prone states should be independent of the number of persons living in a county, allowing differences in the rate of F3 or stronger tornadoes to be attributed to inhabitant density. [2]

For further evidence on this point I turn to individual tornadoes in the United States from 1950 to 2002, as reported in the SPC archive (http://www.spc.noaa.gov/archive). I calculated the population density for the county or counties struck by each tornado using the county population in the decennial censuses.[3] Nearly 44,000 state tornado segments in the contiguous United States over the period were sorted by population density and broken into quintiles. I then tabulated the distribution of tornadoes by F-scale rating for each population density quintile. Table 1 (available online at http://www.sip.ucar.edu/news/focus.jsp) presents the percentage of violent (F4 or F5), strong (F2 or F3), and weak (F0 or F1) or missing-value tornadoes for each population density quintile.[4] Again, the distribution of tornadoes by F-scale suggests an un-populated-area bias in the rating of storms. The percentage of violent tornadoes in the least densely populated storm paths is less than half the rate in each of the other quintiles. The percentage of strong tornadoes is at least 50% higher in each of the other quintiles. The pattern is consistent, with strong or violent tornadoes that strike sparsely populated areas being less likely to damage buildings and more likely to be rated as weak.

The societal impact of a tornado depends significantly on its Fujita scale rating. One way to illustrate this is to consider fatalities, injuries, and damage per tornado by F-scale category. Table 2 (available online at http://www.sip.ucar.edu/news/focus.jsp) presents these figures for tornadoes in the contiguous United States in the SPC archive. Fatalities and injuries are based on tornadoes from 1950 to 2004; the damage-per-tornado values are based on tornadoes from 1996 to 2004.[5] All three measures of societal impact escalate rapidly with the F-scale rating. In several cases, the impacts escalate by an order of magnitude with a one-category increase in F-scale rating. Fatalities per tornado increase from 0.001 for F0 to 16.3 for F5 (more than four orders of magnitude); injuries per tornado increase from 0.033 to 176 (more than three orders of magnitude); and damage per tornado increases from $23,000 to $259 million (four orders of magnitude). Clearly the impact of tornadoes depends largely on their strength, and if society seeks to reduce that impact, we will need to focus on strong and violent tornadoes.

To evaluate the prospective societal benefits of investments to reduce the impact of tornadoes—such as shelters, sirens, or new weather radars—we need to estimate the annual probability of a tornado. And because impacts result largely from strong and violent tornadoes, we really need estimates of the probability of strong and violent tornadoes. But underrating powerful tornadoes that strike sparsely populated areas biases this estimate downward.

The historical probability of a strong tornado for the most populated counties in tornado-prone states gives us one way to estimate the true frequency of powerful tornadoes. Between 1950 and 1999, the annual rate of F3 or stronger tornadoes per 10,000 square miles for the ten tornado-prone states I mentioned earlier was 0.49. The rate for the most densely populated quintile of counties was 0.89. We can see that the historical rates of violent tornadoes based on F-scale ratings might under-estimate the true rate by as much as half.

This, of course, is just one way to try to estimate the true tornado rate, and it has limitations. One limit is the rarity of tornadoes, particularly violent tornadoes. Schaefer et al. (2002) estimate that the maximum annual probability of a tornado at any location in the United States is 0.0006, which translates to a mean return time of 1,600 years for a tornado at a specific location. Estimating tornado climatologies with about 50 years of records is problematic, but is particularly prone to error if the count of F4 or F5 tornadoes is inaccurate for most of the sample area. The observed frequency of violent tornadoes in a handful of densely populated counties over the last 50 years might deviate significantly from the true but unobserved frequency.

What can be done about this? Very little for the historical record. Overall, the F-scale rating of tornadoes proxies tornado intensity well enough that tornado records allow meaningful research on societal impacts. In the near term, the NWS could possibly attempt to note and make available to researchers the number of tornadoes that might have been stronger than their F-scale ratings. F-scale ratings represent a *minimum* rating of a given tornado for the damage actually done (Schaefer et. al 1986), but to assess societal vulnerability, researchers will want to know whether the *maximum* rating could have been higher. An estimate of how many tornadoes could have been more powerful than their official F-scale rating, even if just for a couple of years, would give us a valuable tool with which to reassess risk based on the climatological record.

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*A vehicle flees an F3 tornado as it reaches its peak near Akron, Colo. (Photo by Gregory Thompson; http://www.inclouds.com.)*

# The Warning Project:

***Toward Improved Understanding of Warnings for Short-Fuse Weather Events***

**by Eve Gruntfest,[1] Charles Benight,[2] Mary Hayden,[3] Sheldon Drobot,[4] Lindsey Barnes,[5] David Schultz,[6] & Julie Demuth[7]**

## *Introduction*

While the physical sciences have shown dramatic improvement in offering increased lead-times, better long-term models, and integrated real-time monitoring, the social science research necessary to translate the new knowledge into improved responses is missing. Few studies have explored how technological innovations, increased mobility, an increasingly information-dependent society, and population demographics affect the ability to forecast and warn citizens about impending short lead-time hazard events.

In 2003 Eve Gruntfest and Charles Benight, professors at the University of Colorado at Colorado Springs, received NSF funding to improve understanding of public perceptions of warnings for flash floods and tornadoes. The project called for development of a survey (questionnaire) to be administered in two growing ethnically diverse cities: Denver, Colo., and Austin, Texas. The initial research team consisted of a geographer with an established reputation in flash flood research in Colorado and a psychologist with an extensive background on trauma, related to natural hazards and other extreme events.

This brief summary of The Warning Project shares highlights both from the findings we are currently writing and submitting for publication and from the new team member contributions made possible largely because of WAS*IS (Weather and Society Integrated Studies, see www.sip.ucar.edu/wasis). The research aimed to help emergency managers and NWS forecasters update and improve short-lead-time weather warnings in the United States. Two main characteristics of this project that distinguish it from earlier work are its interdisciplinary approach and its focus on the broad definition of “the public”.

Survey questions assessed
(1) Warning sources utilized, including “new” sources such as cell phone and Internet
(2) Experience with false alarms
(3) Attitudes toward government
(4) Previous experience hazards
(5) Physical understanding of the potential hazards
(6) Demographic characteristics including previous trauma experiences
(7) Coping self-efficacy perceptions for warning response
(8) A range of responses depending on various lead times

Two brief flash flood scenarios were also included based on actual severe weather events in both Denver and Austin. These were followed by warning behavior questions to provide a realistic warning context for respondents facing imminent severe weather conditions: one was based on being at home and the other on driving. Of 3,000 households selected in Denver and in Austin, 1,031 returned the questionnaire.

## *Findings*

The major finding provides compelling evidence that improvements in warning communication and response depend on agencies’ acceptance of the notion that there are many publics, each with its own particular set of preferences for information. Willingness to respond to warnings goes beyond age, ethnicity, and gender differences. Our findings show that respondents are distinguished by location, earlier trauma experiences, and life stage.

Warning perceptions and response depend on numerous characteristics that deserve much more study. How does seasonality and the expectation of severe weather during a particular time of the year influence perceptions? Each individual’s role as a parent, teacher, official, or employee, for example, affects perception and response. Diverse interests in probabilistic information and willingness to accept and interpret uncertainty need to be accommodated in warning messages. Implementing this recommendation requires comprehensive rethinking of the entire warning enterprise—from forecasting to public education to warning dissemination.

## *Summary*

The Warning Project findings highlight the need for further research that depends on qualitative techniques to identify how best to tailor messages to reach subsets of vulnerable populations.

The project dataset has been divided into particular themes to learn as much as possible about how to improve short-lead-time weather warnings. Other researchers have joined the original research team, helping analyze and present aspects of the data. Two physical scientists who participated in the first WAS*IS workshops (sponsored by SIP) became Warning Project collaborators: Sheldon Drobot, whose background is primarily in sea-ice forecasting, and David Schultz, who is a mesoscale meteorology expert. Both are focusing on particular subsets of the data.

To suggest ways of improving warnings, Sheldon will identify which characteristics of our survey respondents distinguish between those who say they would or would not drive through flooded roads. David’s attention is on how coping self-efficacy affects behavior in response to tornado warnings. In addition to an overview manuscript, we expect two other papers to result from this study, with the topics that follow:

(1)Warning source and timing influence public willingness to respond to hazard warnings. How do people prefer to get weather information?

(2) High levels of official concern about “false alarms” may be unwarranted and may reduce warning issuance and effectiveness.

Our study shows recognition of the difficult nature of forecasting short lead time events and a preference for “false alarms” rather than unwarned events. Close evaluation of this issue calls into question how NWS personnel verify their warnings and urges new metrics that consider a continuum that includes those close calls and near misses rather than just a hit or miss option. Graduate student Lindsey Barnes has taken the lead on this piece, which has already been accepted for publication in *Weather and Forecasting.*

***Future Research***

Sheldon Drobot is leading the work on a new proposal for submission to NSF. This effort will include more in-depth studies of how people prefer to receive information on potential hazards and will also try to learn, through virtual and field trials, the actual behaviors of drivers facing flash flood and tornado conditions with and without official warnings, and with and without environmental cues. We anticipate including another WAS*IS-er, Isabelle Ruin from the University of Grenoble, who is finishing her Ph.D. in geography and studying behavior during flash flood events. Laboratory simulations showing localized conditions and changing conditions also have potential for evaluating the effectiveness of particular risk communication modes and even word choices.

Please write to us if you would like a copy of the team’s recent presentation in Austin to the officials involved in warnings and emergency preparedness. A summary of our December 11, 2006 Austin presentation by Austin’s news channel 8 can be found on the web at http://www.news8austin.com/content/your_news/default.asp?ArID=176337&&&.

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# Conferences & Opportunities

***International Conference on Socio-Economic Benefits of Weather, Climate and Water Services***

**Date:** March 19-22, 2007
**Location:** Madrid, Spain
**Organizer:** World Meteorological Organization (WMO)

This international conference will provide a contemporary global assessment of the influence of weather, climate and water on the major socio-economic sectors worldwide. It will be an opportunity to evaluate and enhance the social and economic benefits from the use of meteorological, hydrological and related environmental information and services, particularly in decision-making and reduction of risks. It will provide an important occasion for representatives of the various weather, climate and water-sensitive sectors of society to describe how the environment impacts them; how weather, climate and water information helps them make decisions and reduce risks; and how decision-making could be improved through new or improved services.

To obtain further information about the conference, especially travel arrangements including visas, hotel accommodation and the conference program, please visit www.wmo.int/Madrid07 or email Madrid07@wmo.int.

***2007 Summer WAS*IS (Weather and Society * Integrated Studies) – Call for Applications***

The National Center for Atmospheric Research (NCAR) Societal Impacts Program (SIP) is happy to announce that it will be holding a 2007 Summer WAS*IS workshop, contingent upon funding. WAS*IS is a movement to fully integrate social science into meteorological research and practice. WAS*IS is doing this by building an interdisciplinary community of practitioners, researchers, and stakeholders who want to learn and explore new tools, methods, and concepts for more effective socio-economic applications and evaluations of weather products.

See our Web page (http://www.sip.ucar.edu/wasis/) to read more about WAS*IS and to apply for the 2007 Summer WAS*IS workshop. Applications are due **Monday, March 26, 2007.** Please contact Eve Gruntfest (ecg@uccs.edu) or Julie Demuth (jdemuth@ucar.edu) if you have questions.

***2nd National Forum on Socioeconomic Research in Coastal Systems***

**Date:** May 20-23, 2007
**Location:** New Orleans, Louisiana
**Organizer:** Center for Natural Resources Economics and Policy (CNREP)
**Abstract Deadline:** February 15, 2007

The catastrophic damage associated with the 2005 hurricane season has focused national attention on the environmental challenges faced by the Gulf Coast region. This multidisciplinary conference will highlight the status and challenges of socioeconomic research on and policy for coastal systems focus on restoration, resiliency of communities and resources, and the economics of extreme events. For more information, visit: http://www.cnrep.lsu.edu/ and visit the links under CNREP 2007 on the left navigation menu.

# Extreme Weather Statistics at Your Fingertips

**by Emily Laidlaw***

Chances are you've personally experienced at least one extreme weather event such as a hurricane, a flood, or a drought. But if you needed specific statistics on the losses caused by these events—damage dollar amounts, insured property losses, and numbers of fatalities and injuries, for example—would you know where to look?

If you haven't heard of the Extreme Weather Sourcebook, you could be missing out on a wealth of useful data. The sourcebook is a simple, user-friendly Web site (http://www.sip.ucar.edu/sourcebook) that hosts a comprehensive database of U.S. extreme weather impacts statistics, sorted by state and dating in some cases back to 1900. You can view these statistics in several ways: alphabetized by state name, ordered by numerical rank, or listed from the state with the most losses to the state with the least losses.

The Lightning section currently features the greatest variety of data, ranking the number of lightning fatalities, injuries, and damage reports since 1959. There's even a chart that compares casualty and damage reports for each state. In the Other section, you'll also find a variety of interesting data, such as the annual average number of hail days and crop-hail, insurance-loss cost values since 1950.

Although right now the sourcebook contains data only through 2001, SIP staff members plan to begin adding more recent data to the site early this year. During the short time since SIP acquired the Web site from Roger Pielke, Jr. and his colleagues at the Center for Science and Technology Policy Research in August 2006, the number of sourcebook hits has increased by nearly 200%. We think this proves that the Extreme Weather Sourcebook merits not only preserving but also improving and promoting!

The SIP staff would like your feedback on the sourcebook. For example, how useful do you find the current information? What data would you like to see added? Can you suggest design features that might make the Web site more user-friendly? To submit feedback on these and other topics, please send your thoughts to Emily Laidlaw at laidlaw@ucar.edu.

*Emily (laidlaw@ucar.edu) is an Associate Scientist with NCAR's SIP. For more on our collection of community information resources, please visit http://www.sip.ucar.edu/resources.jsp.

***Our Science*** *(continued from page 1)*

At the same time, the value of accurately knowing tomorrow's maximum and minimum temperatures (and hence future electricity demand) has increased. In contrast, water resource managers operate under a complex web of regulatory constraints (such as looking after the interests of the public, utilities, farmers and ranchers, fisheries, and indigenous peoples) that works against the use of forecasts in decision making (Rayner et. al 2005).

The previous examples, just two among many, illustrate the profound effect of policy on forecast value. Such examples strongly suggest that the key to increasing society's ability to benefit from science lies primarily in the realm of communications, social science, policy, and even politics. Many physical scientists are uncomfortable operating in this sphere. The Navier-Stokes equations are silent on such subjects. The world of politics has a different set of rules. Accordingly, we should tread more cautiously, and arguably a lot more humbly, when on political or economic ground.

***In the future, scientists, policy makers, and the public will have to collaborate more effectively if scientific advances are to rapidly improve the human condition.***

Here's one mistake we make. We think that if society is not benefiting from our work, it's primarily because we simply haven't articulated those benefits with sufficient clarity. We focus on improving our story, on using terms a layperson can understand, on broadening the reach of our message. But in fact, it's far more likely that we haven't *listened* closely to what society has been telling us it needs.

Take an example of an institution that listens well as part of its culture—NCAR's Research and Applications Laboratory (there are other success stories, but this one is close to home). The RAL Web site focuses on end use and end users. And RAL's management and staff are often on the road, visiting customers on site. Need a model to gauge your own abilities in this regard? Think about your significant other. If you're meeting his or her needs, chances are it's because you listen—and respond—well, not because you can make an eloquent case for what a nifty person you are.

In the future, scientists, policy makers, and the public will have to collaborate more effectively if scientific advances are to rapidly improve the human condition. And I'm overstating here a

# Review of Marshall Frech's *The Water's Edge*

**by Ilan Kelman***

Flood disasters continue to cause devastation across the United States and around the world. Recent catastrophes, each of which killed over 1,000 people, include Hurricane Katrina in 2005 and a December 2006 typhoon in the Philippines. These disasters bring up fundamental questions: Does everyone suffer equally? Why are flood disasters increasing? What makes people rebuild flood-destroyed communities? Which flood myths dominate our thinking?

A new DVD by Marshall Frech, a Boulder, Colo.-based flood safety educator, answers these questions. *The Water's Edge* is a critical documentary that describes systematic failures in our behavior, decisions, and values, failures that lead to more and worse floods in the United States—irrespective of changes to the weather and climate. Dramatic flood footage, showing water's immense power and the terrifying dangers to people caught in it, is interspersed with interviews with people who truly understand floods.

Frech doesn't only seek out scientists. He also interviews people who have suffered flooding, losing everything they own and sometimes their loved ones too. Yet some of them rebuild in exactly the same place. Their powerful explanations—"I love this water"—capture some of the fundamentals of our increasing vulnerability to floods: moving into floodplains, river and coastal engineering, faith in technology such as dams to protect us, and long-term policies that favor the transfer of risk from the wealthy elite to individual homeowners.

*The Water's Edge,* which is now airing on PBS stations around the United States, shows that flooding is natural, but that we, not nature's foibles, cause flood disasters. We know too much to call floods "natural disasters."

For more information and clips from the DVD, see http://www.thewatersedge.tv

For general flood safety information and tips, see
http://www.floodsafety.comhttp://tadd.weather.gov
http://www.floodsafety.noaa.gov
http://www.ucar.edu/communications/factsheets/Flooding.html

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bit, but if SIP's *Weather and Society Watch* is to contribute usefully to the process, it should become a communications vehicle where users can be heard and meteorologists can listen.

*William Hooke is the Director of American Meteorological Society Policy Program and a Senior Policy Fellow.

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*Extreme weather events such as this one demonstrate the widening gap between the advance of science and society's abilitiy to use it, as referenced by William Hooke's article. (Photo courtesy of http://www.bigfoto.com*

***Fujita Scale*** *(continued from page 5)*

In the future, technology will allow scientists to measure wind speeds in many if not all tornadoes. Because of the curvature of the earth, current NWS Doppler radars do not observe the lowest levels of thunderstorms. NOAA now has Doppler-on-Wheels (DoW) radar units that sometimes observe tornadoes, and undoubtedly more storms will be observed in this fashion in the years to come. The Collaborative Adaptive Sensing of the Atmosphere project, a joint research collaboration among the University of Massachusetts, the University of Oklahoma, Colorado State University, and the University of Puerto Rico, is experimenting with a dense observing network of low-power radars.[6] Such a system has the potential to observe the intensity of tornadoes. And Phased Array Radar, a technology now in the development phase (which is unlikely to be deployed for at least ten years), offers the potential to observe tornadoes as well (National Severe Storms Laboratory 2003). The ability to directly observe intensity will be a major benefit for research on and efforts to predict and reduce the societal impact of tornadoes.

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### Footnotes

[1]The states were Arkansas, Iowa, Kansas, Louisiana, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas. The SPC archive is available online at http://www.spc.noaa.gov/archive.

[2]The tornado climatologies may differ somewhat. The western parts of the Plains states (Texas through the Dakotas) are less populated, and these counties (which are closer to the Rocky Mountains) could have fewer powerful tornadoes. In addition, the northern plains states are less populated, farther from the Gulf of Mexico, and could have fewer powerful tornadoes.

[3]The values for years between the censuses were estimated using linear interpolation. Annual county population estimates were used for 2001 and 2002 tornadoes.

[4]Missing-value tornadoes are mostly for earlier storms, which were rated based on historical accounts after the Fujita Scale was introduced in the 1970s. An F-scale rating was not assigned if there was insufficient information to classify the damage. Because the missing-value tornadoes resemble F0 and F1 tornadoes in terms of fatalities and injuries, I group them with weak tornadoes.

[5] The SPC archive only began reporting actual dollar damage estimates in 1996. Before 1996, damage was reported in dollar ranges, which means that the numbers cannot be compared.

[6] For more on the CASA program, see www.casa.umass.edu.

# Job Opportunities

### *The University of Oklahoma Applied Social Sciences*

The University of Oklahoma, along with its Center for Applied Social Research, announces a multi-department initiative in the applied social sciences to complement and strengthen existing programs in, and linkages between, the departments of Anthropology, Communication, Economics, Geography, Human Relations, Political Science, Psychology, Social Work, and Sociology.

As part of this initiative the University invites applications for new tenured positions at the rank of Associate or Full Professor.  We are seeking individuals with established world class research programs in any of, but not limited to, the following three areas:
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2) health research and health care policy and practices
3) disaster assessment, preparedness, and management

Candidates must have a Ph.D. or equivalent terminal degree, a proven record of research funding, and an exemplary record of scholarship as demonstrated by publication

For more information on how to apply, please visit the full announcement at http://www.sip.ucar.edu/news/opportunities.jsp.

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days—is found in the northeast corridor of the city in an area of high-density urban and suburban land uses (Stallins et al. 2006). The distribution of cloud-to-ground lightning originating from thunderstorms under weak synoptic forcing environments suggests that land-use type is a driving factor behind enhanced lightning production because of its influence on surface heating and the generation of low-level instability. By contrast, we found frontally forced thunderstorms to have a lowered distribution of flashes over the central city and a lack of affinity with land use in the periphery of the city. This suggests that surface roughness, vertical structure, and dynamical lifting are the more relevant factors driving flash production.

Research results indicate that local contingencies must be considered when documenting urban lightning enhancement and subsequent patterns of hazards. Although we have not examined all possible permutations of thunderstorm type and season, our work suggests that we must employ a more nuanced storm-by-storm, city-by-city approach to document urban flash hazards. Lightning patterns over long temporal scales, when assembled through a judicious selection of flash criteria, can provide evidence for urban flash enhancement. At the same time, we must couple these scales of analysis to smaller-scale studies that provide process-based evidence and reveal the role of local land-use configurations. We are currently using a GIS to integrate insurance-loss data, fire department dispatch records, census data, and flash data. These are being grouped at differing temporal scales to allow us to visualize the influence of regional climate change on urban systems.

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*Lightning strikes near this oil refinery north of Amarillo, Texas. (Photo by Gregory Thompson; http://www.inclouds.com.)*

# About *Weather and Society Watch*

*Weather and Society Watch* is published quarterly by the Societal Impacts Program (SIP) at the National Center for Atmospheric Research (NCAR). The University Corporation for Atmospheric Research (UCAR) operates NCAR with support from the National Science Foundation and other sponsors.

The purpose of *Weather and Society Watch* is to provide a forum for those interested in the societal impacts of weather and weather forecasting to discuss and debate relevant issues, ask questions, and stimulate perspective. The newsletter is intended to serve as a vehicle for building a stronger, more informed societal impacts community.

Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of NSF or other sponsors. Contributions to *Weather and Society Watch* are subject to technical editing at the discretion of SIP staff.

*Weather and Society Watch* is available on the World Wide Web at: http://www.sip.ucar.edu/news/. Archives of WeatherZine, a previous weather impacts newsletter upon which *Weather and Society Watch* was modeled, are available on the Web at http://sciencepolicy.colorado.edu/zine/archives/.

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## About SIP

All aspects of the U.S. public sector, along with the nation's economy, are directly and indirectly affected by weather. Although the economic impacts of weather and weather information on U.S. economic agents have been loosely documented over the years, no definitive assessments have been performed, and information generated from the previous studies is difficult to located and synthesize.

SIP, initiated in 2004 and funded by NOAA's U.S. Weather Research Program (USWRP) and NCAR, aims to improve the societal gains from weather forecasting. SIP researchers work to infuse social science and economic research, methods and capabilities into the planning, execution and analysis of weather information, applications, and research directions. SIP serves as a focal point for developing and supporting a closer relationship between researchers, operational forecasters, relevant end users, and social scientists concerned with the impacts of weather and weather information on society. Program activities include primary research, outreach and education, and development and support for the weather impacts community.

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