

HURRICANE FORECASTING AND WARNING SYSTEM

Workshop Report



Facilitated by:
National Water Research Institute

On behalf of:
National Center for Atmospheric Research

February 16-18, 2005

Kellogg West Conference Center & Lodge
California Polytechnic University
Pomona, California

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FOREWORD

This report is the product of an exploratory workshop facilitated by the National Water Research Institute (NWRI) for the National Center for Atmospheric Research (NCAR) to focus on developing a social science research agenda on the hurricane forecast and warning system.

Hurricanes have significant social and economic impacts that may be mitigated in part by the hurricane forecasting and warning system. The primary goal of such a system is to prevent the loss of life and to reduce vulnerability to winds, storm surges, inland flooding, and other hazards. Significant dividends in terms of relevance and user response may result by better incorporating economic and social dimensions into the hurricane forecasting enterprise.

Held in February 2005, the “Hurricane Forecast and Warning System” workshop was formatted to address a focused question requiring resolution by workshop participants. The question presented at this workshop was: ***What are the priority needs for social science research with respect to the hurricane forecasting and warning system?***

The question promoted discussions among the 30 workshop participants about the social science resources and efforts needed to better understand how hurricane meteorological observation, forecasts, and information products can be effectively translated into governmental and private sector planning, mitigation, and response decisions.

The outcome of the workshop – as presented in this report – are recommendations for research initiatives and projects that can be supported through interagency cooperation, funding for public and private sector academic and commercial research enterprises, and partnerships with private sector information consumers.

The report comprises two parts: Part 1 presents a summary of the top 8 issues identified by the participants during the workshop. Part 2 presents the descriptions of the issues that were identified by the participants. The participants identified 83 issues that were consolidated into 22 overarching themes.

The success of any activity is due in great part to the participants. However, other provided the energy and vision to create the workshop. In particular, special thanks are extended to the NWRI team: Kris Lindstrom, Workshop Secretary, and to the “back-room crew” of Tammy Russo, Workshop Coordinator; Patricia Linsky and Gina Melin, Editors; Barbara Close, Graphic Coordinator; Yan Fredrick, Graphics Assistant; Gaynail Byrd and Anh Do, Word Processors; and Teresa Taylor, Photographer.

Brian J. Brady, Ph.D.
Workshop Facilitator

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GROUP PHOTOGRAPH OF PARTICIPANTS





PRIORITY 1

Improved Understanding of Decision-making Factors

WORKING GROUP MEMBERS:

Dash, Frew, Gladwin, and Massey

Rationale:

- Forecasts and warnings will save lives and reduce property loss if people make the “right” decisions. How do people make the right decisions?
- The wrong decisions are those where people who should evacuate do not, and the people who do evacuate should not (based on emergency management criteria).
- Thus, to have forecasts do what they should, we need to know how people make decisions. We need to learn how people perceive forecasts and use those perceptions in their decision making process.
- Many other factors constrain people’s decisions and options in addition to the forecast. We need to understand how those factors, along with forecast information, result in their final decisions.
- Technology has changed, and people who believe they are technologically “savvy” will make their own assessments of risk. How do these factors impact their decisions to take protective measures?
- Traditional models envisioned a simple process from warning to decision. Today, the process is multi-layered involving multiple decision makers and multiple decision points that often conflict. Differences then result from different interpretations of hazard information.
- We need to consider factors that are not in the traditional approach, such as how people interpret the safety of their homes or businesses. People often weigh this factor against the evacuation order. Related to this is whether mitigation impacts decisions. Do people who mitigate their homes and businesses (such as installing shutters, extra straps, etc.) make their decisions and their forecast evaluations differently than those who do not?

- Basic research questions about risk communication and decision making need to be answered. How are risk indicators communicated to people (in an information/decision chain) who have different expertise, experience, and constraints?

Approaches:

- We need to study actual rather than hypothetical events. Since people tend to rationalize and change their perceptions later, we need to study decisions as close as possible to when they are being made.
- Research funds need to be available for interdisciplinary studies that can be implemented as the event happens and then revisited afterwards.
- Alternative funding sources need to be identified to support research teams ready to act in hurricane areas.
- A mix of research approaches has to be used: start with inductive qualitative interviews (during and immediately after decision making); develop models; and then validate with large sample quantitative surveys (which still have to be done close to the event, probably during the next hurricane).
- All interviews and modeling need to be done in a tight Geographic Information System (GIS) sampling framework to measure the storm effects that decision makers face in a given location and in a local demographic/socioeconomic/cultural context.

Potential Conflicts:

- How do you study decisions when it is difficult to study them while they are being made?
- How can we study different people, yet generalize them? How can we conduct broad-scale work, yet customize it to specific culturally diverse populations?
- A lack of sustained holistic approaches prevents researchers from capturing aspects of the decision process that are salient to different research disciplines.
- How do you get potential funding agencies to understand that research conducted close to the event is a full data-collection effort, not just a pilot study?

Comments:

“Be sure to ask questions such as: Why did you try to go to work, open your business, and conduct a normal life in spite of the storm threat? How many people are irretrievably stuck in set ways of processing information and making decisions?” – ***Jack Beven***

“Globalization = the role and impact of a globalized society in decision making. This is basic needs assessment work used in the first phase of a risk communications campaign. How can this be used in research? What international work can be applied to this issue?” – ***Suzanne Frew***

“This issue is very important because it ties in with response issues. This topic needs more focusing. The business community needs to be included.” – ***John Gaynor***

“Good recommendations about collaboration among researchers. Good program definition.” – ***Mike Lindell***

“We should set up a collaborative work environment for the forecasting and warning group to systematically build and use a body of knowledge, which can be rapidly replicated to the state and localities at risk during events.” – ***Mike McDonald***

“Need to also include decision making in an organizational situation (e.g., business organizations, emergency management, etc.). Decision making by business management can have large impacts on households and the larger public. Also, how local emergency management makes the decision to call for an evacuation equally important. In all of these situations, forecast and warning information from the National Weather Service (NWS) is important.” – ***Walt Peacock***

“Need to break out decision making by different groups (e.g., foundations, etc.).” – ***Ward Seguin***



PRIORITY 2

Estimate the Economic Benefits of Hurricane Forecasts and Potential Improvements of Forecasts on a Variety of Spatial and Temporal Scales

WORKING GROUP MEMBERS:

Beven, Dumont, Lazo, and Weiher

What Are Values?

- Economics is based on a theory of decision making framed as *individual* utility maximization subject to constraints. Based on the ethical system of Jeremy Bentham, total economic value is the simple sum of individual utility.
- Given that economics has a specific set of assumptions about human behavior from which the concept of *economic value* is derived, are there *non-economic values* – NOT meaning non-monetized values but meaning values based on other assumptions about human behavior or based on other value structures? Are there non-economic values that are important to measure, describe, consider in talking about the *value* of hurricane forecasts?
- Specifically, are there *values* as defined by other social sciences that are incommensurate with *economic value*?
- If there are, then what approaches should be used to bring consideration of these non-economic values into policy making with respect to improving the hurricane forecast and warning system.
- Now, taking the economic approach to valuation, which is the *lingua franca* of governmental policy making and resource allocation in the U.S., what is the economic value of hurricane forecasts?
- Estimate the economic benefits of hurricane forecasts and potential improvements of forecasts on a variety of spatial and temporal scales.

Issues:

- Is there a distinction between socioeconomic and economic benefits in terms of methodological approaches?
- Can we distinguish between economic impacts, economic losses, and benefits of the forecasts?
- Is there a distinction between social impacts and economic impacts?

Rationale:

- There are no economically solid and reliable estimates of the public's value for current or potentially improved hurricane forecasts.
- Economic estimates of the value of hurricane forecasts are necessary for justifying current expenditures on hurricane forecasts.
- The value of improved forecasts is needed to support investments in research for improving forecasts.

Approaches:

- Construct an economic performance measure for hurricane forecasts and warnings composed of the:
 - quality dimensions of the forecast
 - value of communication/understanding of forecast variables
 - value of responsiveness to the forecast
- Issues:
 - Is it possible to put a value on forecasts or improved forecasts separate from the whole process of forecast, communicate, perceive, and respond?
 - Does the hurricane problem require new or unique valuation methodologies?
 - Should we provide economic measures of hidden values or vulnerable populations?
 - What other *value* issues need to be addressed?
 - What are the priority sectors (e.g., households, individuals, governments, etc.)?
 - How do we integrate economic studies with other disciplines?
- Potential Challenges
 - What are the potential pitfalls that we face in addressing this issue?

Comments:

“Need to develop bridges between different groups. Need to articulate performance measures and baseline performance measures. Utility framework (used by economists) lets us plug into real money facts. We need to follow through – through the use of multidisciplinary teams. What lessons can be gleaned from other groups, like climate and weather. We risk checking off the Office of Management and Budget (OMB) box and risk missing the societal values.” – **Bob Dumont**

“Too late for questions. Need to write chapters like preparing announcements of opportunity. Need to have cross disciplines.” – **John Gaynor**

“(1) Hugh Gladwin: Utility versus money = economic framework necessary to get cost points at end of analysis. (2) Walt Peacock: Don’t want to divide into homogeneous group; need interdisciplinary work. (3) Ward Seguin: Does this satisfy OMB criteria? Can we learn from climate change studies?” – **Hugh Gladwin**

“(1) This is quite a good preliminary framing used by this group. It is becoming increasingly necessary to systematically examine forecast value, and in doing so very useful information will be collected, organized, and evaluated. For example, in looking at the current effectiveness of conveying predictive information (a factor in the “value” estimation), the dichotomy between precision and accuracy would be addressed, providing much needed feedback to the meteorological community about their targeted efforts to improve forecasts. (2) The challenge in the “value” estimation is the dynamic changes that are occurring in the production, dissemination, and use of the forecasts. Many new public and private sources of expert science information now commonly exist and may continue to increase in the future. Similarly, individuals have ready access to information from different sources, altering their access and interpretation of hurricanes (and other hazards).” – **Sally Kane**

“This working group has a very narrow focus that rejected (repeatedly) any offers by others to bring in related concepts that would have generated a real research focus. The proposed agenda will undercount that socioeconomic impacts of hurricanes and, thus, undervalue forecasts/warnings.” – **Mike Lindell**

“So important to follow the point of following the consequences of improvements or changes in forecast – by working with other social scientists – to be able to determine the full value (and potentially costs) of these changes. We must create multi- and interdisciplinary teams of researchers to address these issues (e.g., economic, valuation, etc.). Otherwise, we are not going to actually generate new novel ideas and knowledge that improve forecast and warning.” – **Walt Peacock**

“Develop performance analysis and compare with PART (OMB performance measurement tool). Compare basic research on socioeconomics versus traditional economic measures. Need to create multidisciplinary teams. Connect to long lead time climate forecast. State as “how can we.....?” – **Ward Seguin**



Hurricane Forecasts and Warnings in the Information Age

WORKING GROUP MEMBERS:

McDonald, Sharp, Simmons, and Sutter

Problems:

- Danger of deterministic-only forecasts.
- Competing and inconsistent messages.
- Not reaching all communities at risk.
- Some misinterpret conflicting messages.

Needs:

- Tailored and personalized messages.
- Interactive messages.
- Multiple channels.
- Ability to make coherent decisions (in an environment of potentially conflicting information).

Research Questions:

- Study how people deal with conflicting information.
- Study how people assimilate changes in messages
- What is an effective compilation of messages in the information age?

Potential Improvements:

- Improve receive infrastructure.
- Enhance collaboration and communication.
- Share scientific visualization.
- Address the psychosocial dimensions.
- Provide self-triage.
- Integrated Knowledge Management System.
- Partnerships.
- Good Housekeeping Seal of Approval.
- Template information (standardized, customized).
- Self-learning system.

Conclusions:

- Concern about coordinating messages through traditional media channels.
- New channels like the Internet.
- Two-way interactive messages.
- What is the message?

Comments:

“(1) Can tailored and personalized messages be done in a way that is not a drain on resources? True two-way communication is a manpower-intensive issue. The Tropical Prediction Center (TPC) is the sole official source of hurricane information (e.g., forecasts, watches, and warnings) for the western hemisphere. All approaches to this problem should be built on this foundation. (2) This report implies that there are circumstances where other forecasters can do more consistent and more reliable hurricane forecast than the TPC. Please specifically document those circumstances or remove that implication from the report.” – ***Jack Beven***

“Need to consider the implications of limited access to new technologies. The so-called “digital divide” will require a multi-method approach with varied technologies, including radio, phones (e.g., land lines and E911), etc.” – ***Susan Cutter***

“Research ways to address closing the digital divide through improved access. What experiences from the international community can be applied to the U.S.?” – ***Suzanne Frew***

“Leverage research on how people process data and its uncertainty. While threat information is being provided spatially (via Internet/GIS) to the public, their “personal” threats can be queried. This can be prioritized by current threats versus inherent threats and combined with safety and educational resources. Explain the risk and explain actions to empower.” – ***Matt Green***

“(1) Susan Cutter: Implicit assumption that everyone has access to the Internet. Need to deal with the digital divide. (2) Mike: Distribution of Internet capabilities and templates from bottom up.” – ***Hugh Gladwin***

“There was a criticism of an argument that the issues of the digital divide were ignored. (Refer to Figures 1 and 2 found in Appendix A.)” – ***Mike McDonald***

“Research question: Should we treat an hurricane forecast like an air quality forecast, such as codes (e.g., red, yellow, etc.)?” – ***Ward Seguin***



PRIORITY 4

Focused Research on Socially Vulnerable Populations

WORKING GROUP MEMBERS:

Gruntfest, Kane, Kiser, and Phillips

Rationale:

- Each member of every community has equal social value and the right to hurricane warnings, regardless of economic status, disability, or language.
- Disasters are not equal opportunity events. The poor lose a disproportionate percentage of their belongings, their housing, their employment, and they have less resilience to recover.

Approaches:

- Need for a longitudinal database, to examine losses compared across economic class, ethnicity, age, gender, and race.
- Need for comparative analysis to see how people perceive, receive, interpret, and respond to warning messages.
- What are some tools that emergency managers can use to remain current with their local community profiles?
- How can these research areas be incorporated into emergency management education and training?
- Research shows that people use networks differently. How do those informal and formal networks work to translate or effectively communicate warning information?
- What are the similarities and differences in behavioral responses within and across groups?
- How can the agencies responsible for disseminating the information be sensitized to appropriate communication methods?
- Understand which agencies link to vulnerable populations and their methods.

- We need know the visibility and credibility of authority figures, including emergency managers and meteorologists.
- How valuable are communication technologies, including the Internet and cell phone text messaging, among the marginalized populations? Remember that more information is not necessarily better.
- New visualization laboratories have great potential for translating scientific and geographic information into real-time revolutionary products – but producing the new maps does not necessarily mean loss reduction. Be sure that the new data and tools are being used.
- Develop a wider range of methodological studies – with rich ethnographic descriptions of how people receive and act on information.
- Identify best practices for community outreach – for public education.
- Document the resources and capabilities of rural at-risk populations. Vulnerable populations bring their own strengths and local knowledge that should be appreciated and welcomed.
- Explore new methodological applications and designs that can be drawn from advertising.

Potential Conflicts:

- Resistance to this type of research.
- Resistance to acknowledge the problems or the necessary resources that will be required to effectively address the issues of marginal populations.
- The situation remains entrenched, and demographic trends indicate that the communication problems are growing.
- Distrust between populations is a major problem especially since September 11, 2001.
- Lack of funding.
- Lack of appreciation for inductive qualitative approaches.
- Challenges of sampling.
- Lack of diversity on research teams.

Comments:

“All populations are at risk in a natural disaster, not just disadvantaged populations. Ensure that use of terms like ‘populations at risk’ reflect this.” – ***Jack Beven***

“(1) Use marketing ‘cultural indicators’ in an initial needs assessment stage (e.g., time perception, acceptance of fate, and religion) that goes much deeper than traditional demographics usually study. (2) Ways must be found to not reinvent the wheel but to apply an extensive body of research and knowledge from social marketing to risk managers (as used in health care, advertising, etc.). (3) Research ways to bring cross-cultural communication theoretical models (e.g., Hagerman, Robert Kohl) into the research and build this body into the psycho-social work. (4) What experience, models, and partners can be brought from the international community?” – ***Suzanne Frew***

“Need to explain the ‘hows’: How do you take advantage of other work that is already being done? How do you define the ‘at risk’ populations?” – ***John Gaynor***

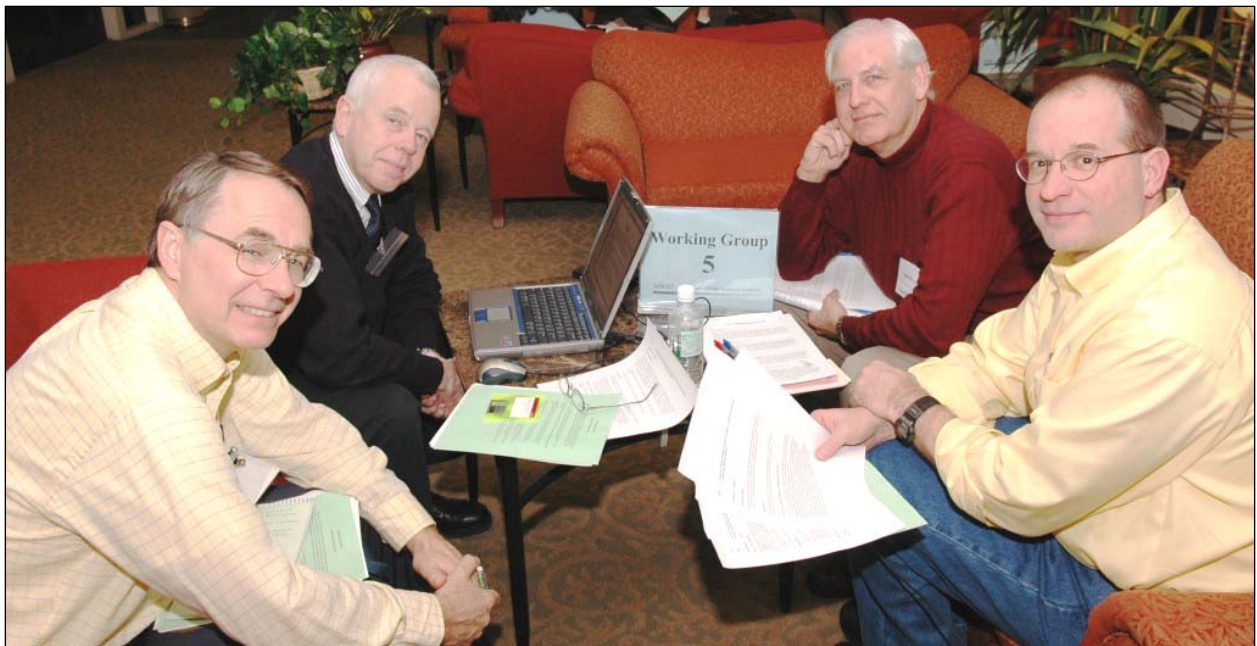
“(1) Ward Seguin: Need to think about how this translates into outcomes required for this group. Look at work on vulnerable populations in other nations. (2) Frank Marks: Added that TPC is responsible for the whole Caribbean. (3) Arlene Laing: On an international dimension, also have to learn from work by other agencies (e.g., U.S. Agency for International Aid [USAID] and U.S. Geological Survey [USGS] regarding international earthquakes). (4) Jeff Lazo: Very important interdisciplinary point is that people have equal value differences from a ‘willingness to pay’ approach.” – ***Hugh Gladwin***

“(1) Many research frameworks (methods) can be used to study the issues raised. Social vulnerability analysis, and decision-making approaches are most directly useful to analyze issues raised in the working group. (2) Standard neoclassical economics are less directly amenable to the study of these issues since many individuals at risk do not participate in the formal political, economic, and legal systems in the U.S.; have few assets of value that can be identified or tracked; and may be transient. Economic approaches that could be used include studies of imperfect markets for forecast information and non-market valuation of goods and services used by the vulnerable individuals. (3) In the U.S., visualization laboratories are being created to study how individuals and groups interpret and use information in decisions. One exciting opportunity is to work with researchers at the National Center for Atmospheric Research (NCAR), and other facilities that house visualization laboratories, to study forecast information to learn about how information is understood in different populations, and how the information can be provided to improve its comprehensibility.” – ***Sally Kane***

“(1) Contact Dr. Alex Coles-Coghi, Center for Disaster Management and Humanitarian Aid (CDMHA), Tulane University, who works with rural communities on disasters in Central America (primarily Costa Rica, Guatemala, and Nicaragua). The CDMHA is also located at the University of South Florida. (2) USGS works with hydrologists in Panama and Nicaragua. (3) National Oceanic and Atmospheric Association (NOAA)/NWS International Affairs also work with Meteorology Services in Central America and the Caribbean. (4) The Cooperative Program for Operational Meteorology, Education and Training (COMET) is working with Caribbean and

Central American Regional Meteorological Training Centers to develop regionally based emergency management training”. – ***Arlene Laing***

“Seek research on short-, mid-, and long-term outcomes versus corresponding performance measures. Approach the State Department for socioeconomic research. Perform research in a multidisciplinary environment.” – ***Ward Seguin***



PRIORITY 5

From Forecasts to Consequences: Develop a Coordinated and Synergistic Social Sciences Research Agenda

WORKING GROUP MEMBERS:

Peacock, Rivers, Seguin, and Willoughby

Issues:

- Develop an end-to-end model of the hurricane forecast and warning system.
- Assess optimal allocation of agency resources to hazard management using decision analysis.
- How do we prepare for the next hurricane, not the last one(s), and how can we learn from other hazards and other places?
- Optimize warning area and lead time.
- Precision in time and space: toward more accurate, geographically focused, and time-sensitive prediction of evacuation rates.
- How can forecasting and warnings address the cascading or ripple impacts of hurricanes?

Rationale:

- Gap between end-user needs for forecast information and what weather services provide.
- Forecasters have traditionally provided what they can and what they think the users *should* need.
- Involve users, forecasters, and social scientists to identify and prioritize users' needs.

Approaches:

- Research agenda to identify gaps and ways to fill them.
- Fundamentally interdisciplinary approach: sociologists, engineers, economists, meteorologists, planners.
- Reward cross-disciplinary cooperative research.
- Case studies, scenarios, broad-based sampling, economic analysis – leading to demonstration projects with good program evaluation.
- Distinction between public and government on one hand, and commercial enterprises on the other.

Potential Conflicts:

- Potential failure to generate immediate consequences.
- Institutional resistance to change.
- Institutionalization of disciplinary turf.
- User apathy and alienation.

Comments:

“There is a need to identify the gaps rather than just say ‘identify them’.” –***John Gaynor***

“(1) Ward Seguin: Very important is the combination of exploratory and confirmatory studies.

(2) Jim Rivers: Of importance are reward structures that support interdisciplinary efforts.” –

Hugh Gladwin

“The point of research is to reduce gaps. A point is that case studies need to be followed by broad-based sampling.” – ***Ward Seguin***

Designing Forecasts and Warnings to Guide Appropriate Responses by Message Recipients

WORKING GROUP MEMBERS:

Gaynor, Lindell, and Marks

Rationale:

- A warning message is a mechanism by which meaning is transferred from a sender to a receiver.
- This communication process is inherently problematic because experts' mental models differ qualitatively from those of novices.
- The same words can mean different things, and different words can mean the same thing to the experts and novices (and some words mean nothing).
- Receivers differ significantly in their degree of expertise and ability to acquire that expertise.
- A good warning:
 - describes the threat
 - provides guidance on protective action
 - indicates where to go for further information
- Expert model of threat information is oriented toward the storm's:
 - track and its uncertainty (error cone/strike probability)
 - forward movement speed
 - intensity
 - size
 - rainfall
- Emergency manager model of threat information is oriented toward the:
 - storm (track and its uncertainty, forward movement speed, intensity, size, and rainfall)
 - community (resident population size and location, transient population size and distribution, and evacuation route system)
 - situation (time of day, day of week, season, concurrent events, such as festivals)

- Local resident model of threat information is oriented toward personal consequences:
 - certainty
 - severity
 - immediacy
 - duration
- Expert model of guidance for protective action:
 - efficacy of evacuation from surge
 - efficacy of shelter from wind
- Risk area resident model of protective action:
 - efficacy
 - cost
 - knowledge and skill requirements
 - time and effort requirements
 - required tools, equipment and vehicles
 - required cooperation with others
- Description of sources for further information:
 - experts tend to recommend other experts
 - warning recipients do look for information from experts
 - however, they also seek information from the news media and peers (friends, relatives, neighbors, coworkers)

Approaches:

- Assess current state of practice in hurricane forecasts and warnings:
 - segmentation of receiver population
 - receivers' perceptions of the information sources (expertise and trustworthiness)
 - receivers' access to *and* preference for information channels
 - receivers' exposure, attention, and interpretation of the message content
- Assess current state of practice in hurricane forecasts and warnings:
 - receivers' assessment of personal threat (protection motivation)
 - receivers' search for threat confirmation and information about protective action recommendation
 - receivers' constraints on protective response

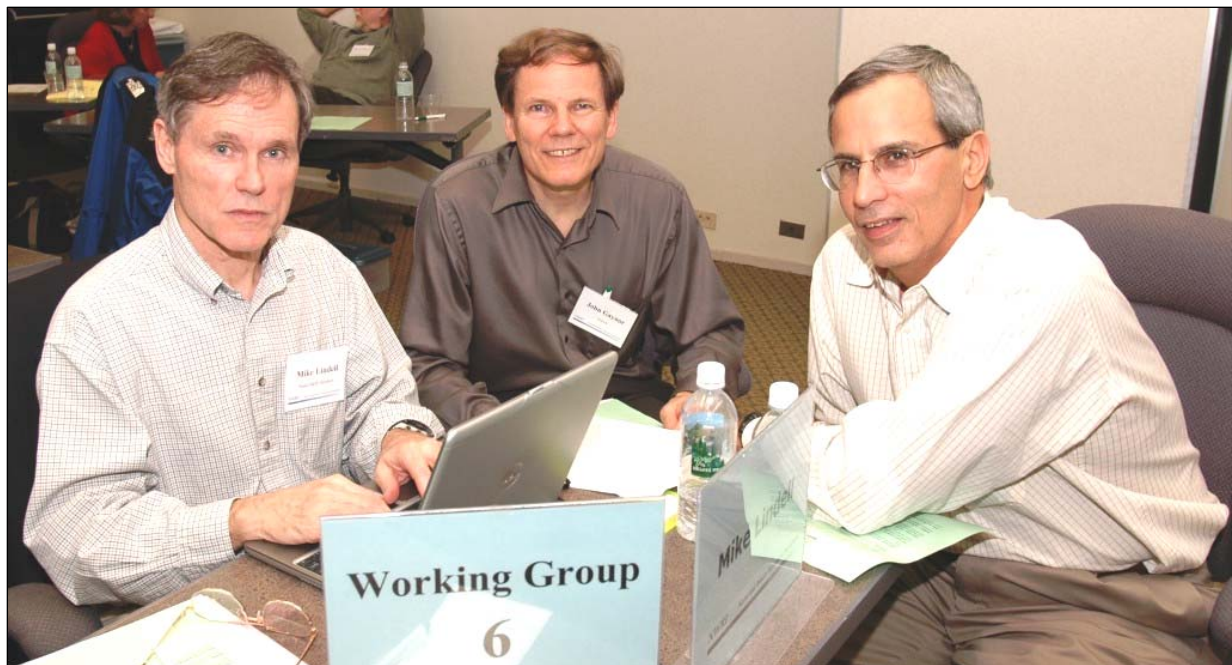
Potential Conflicts:

- NWS has a long track record of success in implementing its existing method of operation, which limits the incentives for change.

- This raises the question of whether it can continue to be successful in a changing environment defined by:
 - rapid emergence of new information technologies
 - competition from other information providers
 - risk area residents' changes in attitudes toward authoritative assessments (NWS/Local emergency management)
- NWS information product formats are prescribed by NWS Directive 10-601.
- This limits flexibility by hurricane specialists.

Comments:

“How good are friends, family, and social groups for assign along information? My experience suggests that is a good way to propagate *misinformation*.” – ***Jack Beven***





Precision Versus Accuracy: Are Risks Adequately Expressed by Current Deterministic Forecasts?

WORKING GROUP MEMBERS:

Green, Leatherman, and Prater

Rationale:

- Level of uncertainty in extreme weather forecasts is high, and the penalty for error is higher.
- Deterministic forecasts imply more accuracy than is present.
- Very attractive presentations are seductive but do not necessarily communicate the risk accurately.
- Probabilistic forecasts may be hard for decision makers and the public to understand, yet they more accurately convey the uncertainties involved, and we know the recipients of risk communication value accuracy and consistency.

Approaches:

- Examine the research literature in mass communications.
- Examine the research literature in warning communications (e.g., social science and meteorology).
- Evaluate the distinct roles of deterministic, probabilistic, and categorical (e.g., index) forecasts.
- Surveys and focus groups to determine how well various sectors of society understand probabilistic or categorical forecasts.
- Private sector meteorologists, emergency managers, public officials, and mass publics.

Potential Conflicts:

- Raising questions about the move toward deterministic forecasts could be met with institutional resistance.
- Increase competition for funding.
- This research needs to be truly interdisciplinary to answer the questions we are raising.
- There may be no easy solution to balance the need for precision and accuracy.

Comments:

“The mere existence of a graphics product may imply an accuracy we do not have.” – ***Jack Beven***



Coordinated Research Designs and Methodological Improvements in Evacuation Behavior Research

WORKING GROUP MEMBERS:

Cutter, Laing, and Letson

Rational:

- Results of current post-evacuation behavioral studies are not comparable, verifiable, or released in a timely manner.
- Present system of post-evacuation studies is not based on the current understanding of behavioral intentions and methods of modeling evacuation behavior.
- Advancements in research are inhibited by lack of protocols and innovative methods, thereby diminishing its utility to local emergency managers.
- Data sharing protocols are standard in other disciplines and required by many funding agencies.
- Roadblocks to research; use different survey designs.
- No normalization of data (e.g., size of population, geography, etc.):
 - inconsistency in questions asked
 - no longitudinal information
 - restricted access to data from publicly funded research

Approaches:

- Create a national clearinghouse for pre- and post-evacuation studies.
- Establish research protocols using scholarly journals requirements as a model.
- Promote rapid funding for pre-event, real-time, and post-event surveys.

- Develop simulation frameworks for modeling evacuation behavior, including transportation, sheltering needs, etc.
- Utilize new spatial analytic methods and tools (e.g., GIS, neural networks, decision trees, simulations, tools for access and integration of diverse datasets).

Potential Conflicts:

- Privacy protection mechanism is critical.
- Perception that results and data are proprietary.

Comments:

“Won’t people have better things to do during a hurricane threat than to answer surveys?” – ***Jack Beven***

“This was the best report. It dealt more with the ‘hows’ rather than just asking questions.” – ***John Gaynor***

“(1) It is very important to establish consistent survey research protocols, but we need inductive qualitative research first to ensure we are asking the right questions. (2) Ward Seguin: Standardize surveys; standardize set of common questions and then encourage different subsets of questions particular to a given survey. An example: formulate different types of surveys. Class A might be a small sample, initial surveys. Class B might be baseline decisions, full scale survey. (3) Bill Massey: At the Federal Emergency Management Agency (FEMA), have to get OMB approval, which is much harder than university Institutional Review Board. Perishable knowledge is getting older day by day and is not surveyed.” – ***Hugh Gladwin***

“Data-sharing protocols, a clearinghouse, and a rapid funding mechanism are also critical for improving our understanding of the differences between how people do respond to warnings versus how they say in a survey how they might respond to a hypothetical warning. For economists, this is the stated-preference versus revealed-preference debate. In sociology, psychology, and anthropology, concerns about hypothetical responses abound, and advancement is possible across these disciplines.” – ***David Letson***

“Good focus, many benefits, excellent discussion. This group identified a low-cost way to generate a tremendous number of new findings. This is even a higher priority than I previously assumed.” – ***Mike Lindell***

“Need to obtain and analyze the past 15 years of post-storm behavioral studies; request data from FEMA. NOAA’S CSC could be a clearinghouse.” – ***Bill Massey***

“Wonderful; need to implement many of these questions and recommendations. Pushing FEMA to release previous data is important as well.” – **Walt Peacock**

“Use of existing data from agencies like FEMA can be both beneficial and problematic. For example, FEMA’s tele-registration center does not record some basic demographics like race and ethnicity. Therefore, we should encourage greater collaboration between agencies and researchers in order to make potential data sources for a national clearinghouse more useful. Let’s fund that national clearinghouse!” – **Brenda Phillips**

“Should a community develop and publish standards or guidelines for research? Develop differing classes of surveys (based on scope, sample size, etc.). Develop standard questions, which go through a national clearinghouse.” – **Ward Seguin**

PRIORITY 1

Improved Understanding of Decision-making Factors

Originators:

Dash on behalf of herself, Frew, Kiser, Gladwin, Green, Lindell, Marks, McDonald, and Rivers

The following issues were consolidated under the above title:

Title: Improved Understanding of Decision-making Factors

Originator: Dash

Issue Description:

We need to better understand how decision makers use and interpret forecast information. Many appear to use information, but instead of relying on the judgments of experts, they use the information (via the Internet, the Weather Channel) to assess their own risk and danger.

How do household decision makers interpret, translate, and then use information to determine their risk? Without understanding this process and what influences it, we will not be able to effectively improve forecast and warning messages.

We know a lot about the characteristics of who responds and who does not, but this is not always consistent.

Importance:

By understanding the process people go through to determine risk and the protective measures they adopt, we will know where forecast and warning improvements can be most effective. While we acknowledge the importance of this process, we do not have a lot of information about it.

How Do You Propose Meeting or Complying with This Issue?

Social science research needs to become more of a priority, and new methods of research need to be implemented. We must move away from looking at the issue linearly; instead, we need to model its complexities. Research needs to be implemented before these events occur and then confirmed after. While some of this research is already underway, more is necessary to get the information required for better modeling.

Title: **Use Sociocultural Indicators to Build Cultural Profiles of Individual Population Groups**

Originator: Frew

Issue Description:

Demographics in the U.S. are quickly changing, particularly with such groups as immigrant populations. Warnings focus on physical conditions and provide direction but often fall short of effectively connecting with many populations' decision-making processes. The warnings do not reflect any psycho-social characteristics or cultural traditions in the message creation, technologies, or distribution channels. A "one size fits all" message, or simply changing the language, ignores the critical role that cross-cultural factors, based on long-standing theory, play in risk perception, personalization, and action.

Importance:

Cultural differences dramatically influence access, perception, credibility, and action. By using the cross-cultural theory to help formulate and implement risk communication, we can increase mitigation and evacuation responses. Values and attitudes – regarding life and death, time perception, circles of influence, fate, and comfort with technology – are characteristics or "identifiers" that drive community decisions. Currently, meteorology addresses only the tip of the cultural iceberg, not the deepest issues that motivate individuals.

How Do You Propose Meeting or Complying with This Issue?

- Research ways that social marketing strategies that are heavily used in other professions (e.g., marketing, healthcare, and advertising) and that are in the process of being used in other global regions can be applied to warning, forecasting, and other mitigation activities.

- Work with key stakeholder groups to build cultural profiles in a needs assessment stage, using cross-cultural identifiers or characteristics.
 - Build public-private efforts to craft the messages, campaigns, and tools for pre-events and during the event.
-

Title: **Motivate People to Make Informed and Intelligent Decisions**

Originator: **Kiser**

Issue Description:

- Hurricane Charlie – was it just a track chart?
- Why were some areas impacted by Isabel surprised by the height of the storm surge?
- Is it education, improved products, better coordination with decision makers, lack of experience, or over-hype by the media?
- How do citizens sift through this maze of information, inject their personal experiences, and arrive at informed decisions?
- It is not just those that stay, but also that there are those who leave and do not have to.

Importance:

- Reduce revenue loss (5-day forecast).
- Reduce deaths and/or damages.
- Lower evacuations result in lower evacuation costs. Those that should leave can get out.

How Do You Propose Meeting or Complying with This Issue?

- Focus groups.
- Questionnaires.
- Surveys.

Title: **The Role of Risk Measurement Scales and Scenarios in the Content and Flow of Information from Forecasters to Decision Makers**

Originator: Gladwin

Issue Description:

There is a need to more closely study the content and flow of information from forecasters to decision makers (decision makers being both officials who make evacuation calls and people who are supposed to evacuate when ordered). The need is to look more closely at what people are thinking and doing when they comprehend and act on forecast warning messages. How do people use warning information? How often do they simply take and accept what they hear? How often do they gather information and then interpret it for themselves, and how do they do the interpretation?

Importance:

This is important because it tells forecasters and others down the information line how to best shape and communicate forecast messages. It is essential to know how people comprehend scales and diagrams like the Safford-Simpson Hurricane Scale (SSHS) and strike probability diagrams.

How Do You Propose Meeting or Complying with This Issue?

These are questions about cognition, and more cognitive research should be incorporated to understand evacuation thinking and decision making. People interpret warning messages in terms of their beliefs and knowledge. These are usually remembered as scenarios or stories, often taking the form of causal relations – beliefs about likely consequences of events that get modified through experience.

Other important cognitive work to incorporate is what is known as “socially distributed cognition.” This work studies decisions made by groups of people with different areas of expertise and authority, often in situations where considerable risk is involved if decisions are not made correctly. In such circumstances, correct information transmission is critical and relies on commonly understood measuring scales. This is difficult in situations such as hurricane warnings where forecasters, emergency managers, and the public have very different levels of expertise and understanding of scales and diagrams representing hurricane risk. The work needs to be a connected systematic analysis rather than anecdotal.

Title: **Do People Evacuate Because Elected Officials Say So?**

Originator: **Green**

Issue Description:

Do people evacuate because a local official tells them to? Do the people that evacuate reach this decision gradually, or like a switch (when called for, they act)?

What are the cues to begin preparations? Do people look to local officials for these cues or do people conduct a self-evaluation to determine their own vulnerability?

Importance:

It is important to determine these triggers to fine tune how we communicate the message to maximize the response.

How Do You Propose Meeting or Complying with This Issue?

Conduct surveys and focus group meetings.

Title: **Drowning in a Sea of (Mis)information: Heuristics for Avoiding Cognitive Overload**

Originator: **Lindell**

Issue Description:

Research in cognitive psychology has thoroughly documented that experts have qualitatively different cognitive structures from novices and, especially, that people use heuristics rather than formal rules of statistical inference in making decisions under uncertainty. Deviations from normative rationality models are observed under relatively simple, inconsequential and frequently encountered situations; so complex, critical, one-of a-kind decisions would be more problematic.

Importance:

Heuristic processing could produce a significant loss of life if it leads to erroneous decisions about protective action.

How Do You Propose Meeting or Complying with This Issue?

Research is needed to understand how expert representations (e.g., uncertainty cones and strike probabilities) are interpreted by other population segments. Uncertainties about other storm parameters and also evacuation time estimates should be studied to see how people assess its relevance, evaluate the credibility of its source, interpret its meaning, and integrate it into decisions about whether and when to evacuate.

Title: **Hurricane Andrew Was a Category 5? So What?**

Originator: **Marks**

Issue Description:

The public's perception of hurricane impacts is dominated by a few simple measures. Many people in South Florida believe they survived a category 5 storm, when in fact only a small percent of the population experienced the category 5 impacts. This impression leads to varying assessments of risk in the future.

Importance:

The interpretation of risk is partially based on experience. Risks need to be better represented on a finer scale than on a single measure like an SSHS number. Otherwise, people develop a false sense of security risk.

How Do You Propose Meeting or Complying with This Issue?

- Need to develop better measures of impacts from storms than just a single number (e.g., SSHS) that better reflect variability across the storm.
- Need to review the new measures with customers and professionals to ensure its meaningfulness.

Title: **Use Simulations to Enable Collective Retrospective Decision Making Prospectively through Disaster Knowledge Management Systems**

Originator: **McDonald**

Issue Description:

New tools and methods – such as self-replicating collaborative work environments linked to scientific visualization, psychosocial assessment, and community engagement in alerts, warnings, and risk communication using health parameters as measures of success – show promise of significantly improving the health and social effects of weather, especially in disadvantaged communities. Establish a disaster knowledge management system that can provide a context for making retrospective judgments prospectively, which will reduce vulnerability to adverse health effects of weather and will provide an anticipatory science base that can be repurposed in other disciplines, such as counter-terrorism and other aspects of homeland security.

Importance:

Improve collective survival, response, mitigation, and recovery through better, earlier decision making and prevention.

How Do You Propose Meeting or Complying with This Issue?

Embed forecasting tools into disaster knowledge management systems for the hurricane research community.

Title: **Effectively Communicate and Obtain Appropriate Responses to Forecast/Warning Messages among Small Area Populations: Cognitive, Cultural, and Contextual Factors**

Originator: **Rivers**

Issue Description:

The links among knowledge, attitudes, and behavior are always probabilistic. In the current context, the issue is how links regarding hurricane forecast/warning messages are contingent

upon interacting factors, such as cognitive styles, cultural perspectives, and context, including personal households and the shared experiences of neighbors.

Importance:

A better understanding of the matrix of factors that combine to refract forecasting/warning messages (using neighborhoods and communities as the units of analysis) will allow for more tailored and specific warning messages.

How Do You Propose Meeting or Complying with This Issue?

Conduct multi-site community trials employing multiple message presentations and approaches and carefully selected samples of neighborhoods or small communities.

Estimate the Economic Impacts of Hurricane Forecasts and Potentially Improved Forecasts on a Variety of Spatial and Temporal Scales

Originators:

Lazo on behalf of himself, Beven, Dumont, Seguin, Sutter, and Weiher

The following issues were consolidated under the above title:

Title: **Estimate the Economic Impacts of Hurricane Forecasts and Potentially Improved Forecasts on a Variety of Spatial and Temporal Scales**

Originator: **Lazo**

Issue Description:

I would argue that there are no economically solid and reliable estimates of the public's value for current or potentially improved hurricane forecasts. Valuation studies should be implemented to determine the benefits of improved "meteorological" forecasting, as well as improved communication and decision making.

Importance:

- Economic estimates of the value of hurricane forecasts are necessary for justifying current expenditures on hurricane forecasts.
- The value of improved forecasts is needed to support investments in research for improving forecasts.
- Valuation studies can help guide priorities for determining the type of improvements in the forecasts system that will have the greatest social benefit.

How Do You Propose Meeting or Complying with This Issue?

- Conduct large sample economic valuation studies of current forecasts and improved forecasts.
 - Develop multi-attribute valuation models with conjoint analysis-type valuation surveys to derive estimates of the marginal benefits of forecast attributes.
-

Title: **What Is the Value of a Hurricane Forecast?**

Originator: Beven

Issue Description:

What is the value of a hurricane forecast? Can it be quantified in terms of lives saved, economic impact, or the reduction of damage to property through preparation? What will be the value of improving hurricane forecasts in the future?

Importance:

Are hurricane forecasts economically necessary? The simple answer is yes. However, can they be quantified in ways that are useful in the current budget and bureaucratic climates?

How Do You Propose Meeting or Complying with This Issue?

We need realistic values of the number of lives and amount of money saved by hurricane forecasts.

Title: **Quantify the Socioeconomic Value of Hurricane Forecasts, as well as the Incremental Improvements That Will Result from Incremental Forecasts**

Originator: Dumont

Issue Description:

We must be able to quantify the “goodness” of our hurricane forecast and warning products, not only in terms of the meteorological accuracy but also in terms of the societal and economic

benefits to the nation. Do individuals and businesses take the proper protective actions and evacuate based on a forecast warning product that has a proven level of credibility? Conversely, do they avoid unnecessary evacuations based on that same credible, highly reliable product? We need to be able to quantify the incremental improvements in societal and economic benefits that result from incremental improvements in the forecast product, namely hurricane track and intensity.

Importance:

The Office of the Federal Coordinator for Meteorology (OFCM)-sponsored Joint Action Group for Tropical Cyclone Research is in the process of developing an interagency strategic research plan for tropical cyclones, which will define and prioritize our research needs and requirements for the next decade. If we are to compete for the ever-decreasing number of dollars available for research available within federal agencies, we must quantify the benefits derived for the dollars expended.

Without the research dollars, we will be unable to improve the level of service that we can potentially provide to the nation.

How Do You Propose Meeting or Complying with This Issue?

We need to establish close working collaboration (this workshop being a first step) between the meteorological and socioeconomic communities to further refine the problem and to develop a course of action. Related socioeconomic research needs and requirements must also be documented in the strategic research plan for tropical cyclones.

Title: **Develop Systematic Ways to Estimate the Benefits of Hurricane Forecasts and Their Improvements**

Originator: **Seguin**

Issue Description:

The lack of accepted forecast and forecast improvement values means that such information is not available to drive the focus of hurricane research and operations.

Importance:

Available government resources for hurricane forecasts and their improvements could very well diminish over the next decade. Improved value estimates could stem this decline and could also enable better use of the resources we have.

How Do You Propose Meeting or Complying with This Issue?

Develop strong research programs and facilitate the research community's ability to seek government agency funding.

Title: **Document and Value the Benefits of Improving Hurricane Forecasts over the Past 50 Years**

Originator: **Sutter**

Issue Description:

Try to quantify the number of lives saved, injuries avoided, property damage reduced, and evacuation costs avoided with improvements in forecasts (and warning dissemination) for hurricanes over the past 50 or so years. Data from historical hurricanes can be combined with warning verification records and economic, demographic, and communications variables to provide the basis for estimation.

Importance:

The goal of the larger research project is to try to evaluate the societal benefits from prospective improvements in hurricane forecasts and the elements of warnings and forecasts that could yield the greatest benefits. Prospectively, this involves both estimating what the benefits might be and valuing the benefits. Retrospective valuation of past hurricanes can be easier since records can be examined to quantify the reduction in fatalities, injuries, property damage, and other costs. Evidence from the past can also provide a basis to examine possible benefits from further forecast and warning improvements.

How Do You Propose Meeting or Complying with This Issue?

Evaluate hurricane records with disaggregated information on the location of fatalities, injuries, and damage (hopefully, by county). We would also need hurricane forecast verification records for data on the quality of the warnings for each country, plus false alarm records.

Title: **Construct an Economic Performance Measure for Hurricane Forecasting and Warnings**

Originator: **Weiher**

Issue Description:

To what extent can we construct an index or measure of the economic performance of major products and programs, such as hurricane forecasting?

The economic benefit of a forecast is a function of positive “responses” to the forecast. Can we construct “responsiveness function” composed of the major determinants of value, including:

- The quality dimensions of the forecast.
- The value of communication/understanding of forecast variables.
- The value of responsiveness to the forecast.

Importance:

NOAA has an operational requirement for quantitative performance measures that reflect the economic outcomes (or benefits) of the activity, such as hurricane forecasting.

How Do You Propose Meeting or Complying with This Issue?

Form an interdisciplinary team to specify the “responsiveness function,” and estimate parameters. The first priority is to establish a baseline by completing the household survey work of Jeff Lazo (NCAR), as well as regional value of information studies on hurricane forecasting.

Title: **Priority Needs for Social Science Research: Establish Baseline for Economic Benefits and Examine New Forecast Business Models**

Originator: **Weiher**

Issue Description:

The underlying messages are to:

- Generate a baseline of information on the value of forecasting for planning and budgeting. This includes understanding household values of forecast parameters and regional value of information studies.
- Understand evolving public/private relationships, given the technology/information revolution in forecasting.

Importance:

- Households are the largest consumers of hurricane information.
- The top-down delivery/interpretation of forecasts may be an outdated business model in an age of nearly zero marginal costs for information distribution.

How Do You Propose Meeting or Complying with This Issue?

- Complete the household survey of the value of forecasts.
- Conduct pilot regional value of information studies.
- Begin an assessment of trends in technology/research and information systems in the private and public sectors and analysis of alternative business models, including competitive issues, maximizing distribution of information, cost minimization, etc.

Hurricane Forecasts and Warnings in the Information Age

Originators:

Sutter on behalf of himself, Beven, Frew, Gladwin, Laing, Leatherman, Massey, McDonald, Peacock, Sharp, and Weiher

The following issues were consolidated under the above title:

Title: **Hurricane Forecasts and Warnings in the Information Age**

Originator: **Sutter**

Issue Description:

With the development of the Internet and the availability of more television channels through cable and satellite, residents of coastal areas will have access to more and different forecasts of hurricane paths. Many forecasting models exist, and some will almost always show a storm making landfall or turning and missing the coast. Other sources of information and forecasts besides the NWS will be available. How will this extra information affect response and evacuation decisions by coastal residents?

Importance:

Divergent forecasts of hurricane track and intensity could lead to residents (who do not want to evacuate or who want to deny the threat using a forecast that the hurricane will turn) to ignore an evacuation order. Resort and vacation destination owners may also use these forecasts to assure guests that the hurricane would not affect their vacations. But forecasts that a hurricane will make landfall could lead to unnecessary or over-evacuation. All of this would complicate, perhaps impossibly, the jobs of emergency managers.

How Do You Propose Meeting or Complying with This Issue?

Surveys regarding evacuation behavior in 2004 could address whether residents used the Internet to find other forecasts besides the NWS forecast. Experiments could attempt to see how receiving two or three possible conflicting forecasts about hurricane landfall would affect evacuation decisions.

Title: **Warning/Watch Timing Issues**

Originator: **Beven**

Issue Description:

Time scales of hurricane watches and warnings (24/36 hours) reflect the level of skill in the forecast more than they do preparation times of many areas. Are these still the best way to trigger coastal response, or is there a need to change the system? Would a more multi-level, or probability-based, system work better?

Importance:

Many coastal responses are tied to formal watches and warnings. If they were replaced, could it be done without confusing the public, the decision makers, and the private sector?

How Do You Propose Meeting or Complying with This Issue?

Research to determine what kind of new warning system may be most effective in creating public response.

Title: **What Value Does or Could “Blogging” Have?**

Originator: **Frew**

Issue Description:

The Internet is being used for online dialogues, sharing of expertise, and education. Similar use of technology is being used by organizations like the United Nations in preparation for its

International Strategy for Disaster Reduction tenth anniversary conference held in Kobe, Japan, in January 2005, and for the tsunami response and recovery by the Pacific Disaster Center in Hawaii. The USGS has been using the Internet for feedback in earthquake events.

Importance:

Riding a new technology wave captures younger generations, technology users, and geeks alike. It is a new and powerful engagement tool, great for developing informal networks and for quickly distributing information.

How Do You Propose Meeting or Complying with This Issue?

- Partner with well-known bloggers.
 - Add information on links to sites.
 - Encourage use during community outreach.
-

Title: **Role of Risk Measurement Scales and Scenarios in the Content and Flow of Information from Forecasters to Decision Makers**

Originator: Gladwin

Issue Description:

There is a need to more closely study the content and flow of information from forecasters to decision makers (decision makers being both officials who make evacuation calls and people who are supposed to evacuate when ordered). The need is to look more closely at what people are thinking and doing when they comprehend and act on forecast warning messages. How do people use warning information? How often do they simply take and accept what they hear? How often do they gather information and then interpret it for themselves, and how do they do the interpretation?

Importance:

This is important because it tells forecasters and others down the information line how to best shape and communicate forecast messages. It is essential to know how people understand scales and diagrams like the SSHS and strike probability diagrams.

How Do You Propose Meeting or Complying with This Issue?

These are questions about cognition, and more cognitive research should be incorporated to understand evacuation thinking and decision making. People interpret warning messages in terms of their beliefs and knowledge. These are usually remembered as scenarios or stories, often taking the form of causal relations – beliefs about likely consequences of events that get modified through experience.

Other important cognitive work to incorporate is what is known as “socially distributed cognition.” This work studies decisions made by groups of people with different areas of expertise and authority, often in situations where considerable risk is involved if decisions are not made correctly. In such circumstances, correct information transmission is critical and relies on commonly understood measuring scales. This is difficult in situations such as hurricane warnings where forecasters, emergency managers, and the public have very different levels of expertise and understanding of scales and diagrams representing hurricane risk. The work needs to be a connected systematic analysis rather than anecdotal.

Title: **Improve the Communication of Weather Forecasts**

Originator: Laing

Issue Description:

As information sources become more fragmented and specialized, NOAA needs to adapt its methods of communication at an accelerated pace:

- What can we learn from the use (or abuse) of SSHS categories in decision making and/or the use of Web products developed by “amateur” meteorologists (e.g., near-my-home).
- Loss of attention after the last National Hurricane Center (NHC) advisory.
- Need to direct the media and population to local forecast offices.

Importance:

This is a vital link between the physical science (forecasts) and the social science (response).

How Do You Propose Meeting or Complying with This Issue?

- More studies on citizen understanding of forecast information.
 - More studies on how NOAA can improve its graphical presentations and how to provide information about its level of confidence in the forecasts.
 - More studies on how to represent the evolution of the hazards through the lifecycle of the hurricane (before, during, and after landfall).
 - Develop better communication with the media.
 - SUNY-Albany, Sanders and Westergard – 3-year study.
 - University of Charleston, Charleston NWS office study.
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Title: **Is Saffir-Simpson the Only Hurricane Scale That We Should Be Using?**

Originator: **Leatherman**

Issue Description:

The SSHS was developed for predicting wind damage, and its simplicity is attractive as even elementary school children in hurricane-prone areas have a good understanding of the scale (1 to 5). However, there is no relationship between the SSHS and the amount of rainfall and freshwater flooding (the number one killer in tropical storms).

Importance:

Hurricanes are multi-dimensional hazards, and the SSHS does not convey the true risk from all these hazards (e.g., freshwater flooding, storm surge flooding, etc.). Therefore, people do not always respond appropriately in their best interests.

How Do You Propose Meeting or Complying with This Issue?

How will people respond to several different scales rather than one simple and easily understood SSHS? Will the other scales be helpful or just cause confusion?

Title: Controlling the Media's Message: "Let's keep Jim Cantore off the beach!"

Originator: Massey

Issue Description:

The message provided by the national media to the population threatened by tropical cyclones should emphasize the positive and should re-enforce the correct thing to do. Interviewing surfers and kids unloading kegs from their cars for hurricane parties is not sending the correct message: "If Cantore is still on the beach after I evacuated, it must be safe. Why should I have to leave?"

Importance:

For an evacuation to be successful and save lives, those at risk from storm surge and flooding must evacuate. The information provided by the media should be factual and not sensationalized.

How Do You Propose Meeting or Complying with This Issue?

This is tough since ratings are the driving force for the media.

- Try to educate the media sources on how to provide the right message while at the same time make it interesting.
- Make presentations and do training at the National Association of Broadcasters meetings.
- Meet with the Weather Channel and CNN to relay the problem.

Title: Self Triage for Evacuation and Sheltering during Hurricanes

Originator: McDonald

Issue Description:

The public should receive support regarding their decisions of when, if, and how they should evacuate. Households in high-risk areas could receive calls from an audiotex self-triage system.

Others could test their risks and decision-making by logging onto the Internet or by calling an 800 number.

Importance:

- To reduce deaths and other health impacts due to poor decision-making regarding evacuation.
- Or, on the other hand, to reduce the cost and lost productivity of evacuating when evacuation is not necessary.

How Do You Propose Meeting or Complying with This Issue?

Implement a pilot program based on the MIT, Harvard, Georgetown Biodefense Self Triage and Risk Communication Repository that was proposed for hurricanes.

Title: **Smart Mobs and Hurricanes**

Originator: **McDonald**

Issue Description:

The public is now beginning to use blogs and Internet forums during emergencies – when other communications are bottlenecked – to enable rapid self-organization of small groups to respond to emergencies. Smart mobs could be used for relief efforts, for example, to identify and evacuate special populations (e.g., disabled children). This method could be used to time sequence the evacuation. It could also become a mechanism for criminal activity in evacuation areas. This activity should be monitored.

Importance:

It is expected that smart mobs are likely to become a more frequent phenomenon that could have important implications for rapid evacuation and emergency management in disaster areas.

How Do You Propose Meeting or Complying with This Issue?

Use the semantic to monitor how and when smart mobs are organizing.

Title: **Consistency in Media Warning Messages and Their Influence on Warning Preparation and Evacuation Timing: Deconstructing the Tower of Babel**

Originator: Peacock

Issue Description:

- There is a need for detailed assessments and evaluations of the nature, quality, and consistency in media messages to better understand the consequences for warning, preparation, and evacuation.
- How are the NHC/TPC and local meteorological service messages integrated?
- The Weather Channel and local/non-local news broadcasts are examples of the media sources that must be examined.

Importance:

The media plays a critical role in translating (and sometimes generating) hurricane forecast information and warning the public. But, there is little systematic research comparing the consistency and nature of the translation and its impacts on the public's response.

How Do You Propose Meeting or Complying with This Issue?

- Need detailed monitoring of multiple media outlets prior to hurricane events – conduct content analysis of messages.
- Combine with post-event household survey to assess warning, preparation, and evacuation rates.

Title: **Meet the Increasing Demand for High Resolution (Temporal and Spatial) Weather Information during Hurricane Landfall for Immediate Life-saving Actions**

Originator: Sharp

Issue Description:

There is an insatiable demand for detailed information during landfall. The situational context of each tropical cyclone event provides its own unique challenge, both meteorologically and societally. Importantly, during landfall, it is not prudent to assume that because a tropical cyclone warning has been issued for the appropriate coastal county that everyone is out of harm's way everywhere within the comprehensive impact area, and everything has been done to save lives, even up to the last minute.

Importance:

This is important to fill the information void during the 6- to 12-hour time frame throughout landfall to save lives during the event, not just before. Examples include:

- Charley – 105 mph wind for an inland city prompted a “tornado warning” to grab attention.
- Frances – 900 people had to be safely moved from a failing shelter within the eye of the storm, requiring specialized weather support.
- Jeanne – hurricane fatigue and disbelief prompted an issued statement of encouragement.

These were nontraditional actions.

How Do You Propose Meeting or Complying with This Issue?

- Challenge current product suites and traditional protocols for information dissemination.
- Invest in and maintain the expertise and local knowledge of Weather Forecast Office meteorologists.
- The “bike helmet and protective life vest factor” (1998 Florida tornadoes, head trauma, chest trauma, and flotation devices).
- It is never too late to save a life!

Title: **Priority Needs for Social Science Research: Establish Baseline for Economic Benefits and Examine New Forecast Business Models**

Originator: **Weiher**

Issue Description:

The underlying messages are to:

- Generate a baseline of information on the value of forecasting for planning and budgeting. This includes understanding household values of forecast parameters and regional value of information studies.
- Understand evolving public/private relationships, given the technology/information revolution in forecasting.

Importance:

- Households are the largest consumers of hurricane information.
- The top-down delivery/interpretation of forecasts may be an outdated business model in an age of nearly zero marginal costs for information distribution.

How Do You Propose Meeting or Complying with This Issue?

- Complete the household survey of the value of forecasts.
- Conduct pilot regional value of information studies.
- Begin an assessment of trends in technology/research and information systems in the private and public sectors and analysis of alternative business models, including competitive issues, maximizing distribution of information, cost minimization, etc.

Focused Research on Socially Vulnerable Populations

Originators:

Dash on behalf of herself, Frew, Grundtfest, Kane, and Phillips

The following issues were consolidated under the above title:

Title: **Focused Research on Socially Vulnerable Populations**

Originator: **Dash**

Issue Description:

Research has shown that perceiving risk is one of the most important factors that influence evacuation. Not enough research has focused on how vulnerable populations assess their risk. How might their vulnerability play into their assessments of risk? For example, an elderly women with a cat may never get to the point where she thinks “I’m in danger” when she is concerned with other issues, such as her own health, safety, and safety of her pet.

Importance:

This issue is increasingly becoming more important as we recognize how different vulnerabilities impact different groups of people. Socially vulnerable populations may need different forecast and warning information in conjunction with different educational programs. Indeed, they may also benefit in greater ways from programs that are not cost effective. This has an important social value not included in traditional cost-benefit analysis.

How Do You Propose Meeting or Complying with This Issue?

Focused research on specific vulnerable populations is necessary. The goal would be to try to determine the types of information they consider when deciding to take protective measures, such as evacuation (although protective measures may also be other preparedness activities or even mitigation).

Also, expand the idea of “cost effective” to include things besides dollars. It is technically more cost effective to put \$10,000 worth of mitigation into a \$500,000 home than into a \$40,000 home, but we have to consider the social benefits and determine which household will bear more of a social cost without it.

Title: **Use Sociocultural Indicators to Build Cultural Profiles of Individual Population Groups**

Originator: **Frew**

Issue Description:

Demographics in the U.S. are quickly changing, particularly with such groups as immigrant populations. Warnings focus on physical conditions and provide direction but often fall short of effectively connecting with many populations’ decision-making processes. The warnings do not reflect any psycho-social characteristics or cultural traditions in the message creation, technologies, or distribution channels. A “one size fits all” message, or simply changing the language, ignores the critical role that cross-cultural factors, based on long-standing theory, play in risk perception, personalization, and action.

Importance:

Cultural differences dramatically influence access, perception, credibility, and action. By using the cross-cultural theory to help formulate and implement risk communication, we can increase mitigation and evacuation responses. Values and attitudes – regarding life and death, time perception, circles of influence, fate, and comfort with technology – are characteristics or “identifiers” that drive community decisions. Currently, meteorology addresses only the tip of the cultural iceberg, not the deepest issues that motivate individuals.

How Do You Propose Meeting or Complying with This Issue?

- Research ways that social marketing strategies that are heavily used in other professions (e.g., marketing, healthcare, and advertising) and that are in the process of being used in other global regions can be applied to warning, forecasting, and other mitigation activities.
- Work with key stakeholder groups to build cultural profiles in a needs assessment stage, using cross-cultural identifiers or characteristics.
- Build public-private efforts to craft the messages, campaigns, and tools for pre-events and during the event.

Title: **Interdisciplinary Audits with Attention to Large Hurricanes, Moderate Storms, and Close Calls (There Is No Such Thing as a False Alarm)**

Originator: **Gruntfest**

Issue Description:

- Research old case studies.
- Ask people/locals during the warning and storm periods.
- Watch the use of the Internet.
- Determine the role of pets during disasters.
- Assess how people handle forecast uncertainty (determined versus probabilistic).
- Observe what people are doing, not what they say they are doing.

Importance:

Recognize of how our barriers (e.g., training governmental agency/levels) are perceived and acted upon.

How Do You Propose Meeting or Complying with This Issue?

This is not an easy, one-time fix. Leaders need to be people who are willing to see multiple perspectives.

Title: Improve Outreach Efforts, Using Nontraditional Emergency Management

Originator: Kane

Issue Description:

Outreach can be strengthened by examining community social structures, whether formal or informally organized. Nontraditional sources of hurricane information can be utilized to disseminate and translate critically important hurricane prediction information for populations at risk.

Importance:

With scarce resources available for hurricane prediction communication and outreach, the most effective methods need to be identified and employed, supported by rigorous research efforts. One example of an important research question is whether health caseworkers, community counselors, social workers, and other individuals who are important in the lives of populations at risk can be utilized to disseminate and translate prediction information.

How Do You Propose Meeting or Complying with This Issue?

Employ ethnographies, surveys, and other methods for studying information flows and social relationships in formal and informal social groups.

Title: “Call Grandma”: Reaching High-risk Populations

Originator: Phillips

Issue Description:

- Diverse populations require diverse strategies.
- What works for one population would not necessarily work for another.
- What works within one population must also be diverse to reach across that population’s internal diversity.

Importance:

- We do not have enough tools to put in the hands of those seeking to reach high-risk populations.
- We have not sufficiently generated or disseminated research to those seeking to reach high-risk populations. We lack sufficient means to transfer knowledge.

How Do You Propose Meeting or Complying with This Issue?

- Conduct research on outreach strategies.
 - Infuse emergency management and meteorology education programs with courses on populations at risk.
 - As part of the curriculum, encourage the idea that emergency management requires community relations skills.
 - Train and educate emergency managers and on-air meteorologists.
 - Use social networks and “tell people to call Grandma.”
 - Assess education and training efforts.
-

Title: **Credibility**

Originator: **Phillips**

Issue Description:

To deliver messages effectively, we must do so through credible sources that people trust. Yet, research on who (or what organizations) is most credible to high-risk populations remains to be done. We need to generate studies on the full range of potentially credible organizations.

As Sally Kane said, use outreach organizations to assist high-risk populations. They offer the potential to deliver information through established relationships, existing social networks, and trusted authorities. Outreach organizations may provide the trusted credible sources we need to help deliver information. These are linking organizations; they connect us to at-risk populations.

Importance:

We lack a thorough understanding of who these organizations and agencies might be; how they connect; under which conditions and contexts they are effective; and how we can maximize their resources.

How Do You Propose Meeting or Complying with This Issue?

- Conduct research on who is trusted by whom and determine their credibility.
- Develop a better operationalization and measurement of “credibility.”
- Integrate social work researchers.
- Conduct a literature search on the sociology of the community.
- Theories, models and research exist but remain underused in disaster research “credibility.”

PRIORITY 5

From Forecasts to Consequences: Develop a Coordinated and Synergistic Social Sciences Hurricane Research Agenda

Originators:

Rivers on behalf of himself, Frew, Gladwin, Gruntfest, Lazo, Lindell, and Willoughby

The following issues were consolidated under the above title:

Title: From Forecasts to Consequences: Develop a Coordinated and Synergistic Social Sciences Hurricane Research Agenda

Originator: Rivers

Issue Description:

The workshop question requires establishing inclusionary/exclusionary parameters. For research included by the workshop question, there is a need to decide: limited, but intense, research foci or broader-based research portfolio? Is the emphasis of specific projects for personal safety or property protection? Is the approach to be researched “general,” “indicated,” or “targeted” (i.e., all citizens “at risk,” “geographic areas at higher risk,” or “vulnerable populations at higher risk”)? Priorities should be established on:

- The potential impact on the reduction in morbidity/mortality or specific categories of property.
- The time/effort/expenditures required to produce applicable research findings.

Importance:

- Limited resources and the likelihood that the window of opportunity will soon close dictate choosing projects that have the best combinations of feasibility and payoff.
- Developing a range of social science research issues in the suggested framework requires laying out the broader array of questions that logically link “outcomes” or consequences of tropical cyclone events to forecast/warning. This allows highlighting additional logical elements needing attention that are beyond the limited area of inquiry. It also permits the development of a broader, coordinated, and more effective and efficient overall social science research agenda.

How Do You Propose Meeting or Complying with This Issue?

Organize the product of this workshop; disseminate and follow up on plans using the suggested approach.

Title: **Connections, Connections, Globalization, and Connections: How Can Forecasting and Warnings Address the Cascading or Ripple Impacts of Hurricanes?**

Originator: **Frew**

Issue Description:

Hurricanes and tropical disturbances are generally considered localized events. For example, they hit the Florida coast, but little thinking goes into links with systems outside local communities. What role does globalization play in forecasting and warnings? How can we employ a global, holistic systems approach?

Importance:

Extensive socioeconomic impacts occur outside the direct hit zone. Post-disaster migration shifts eat up economic support in neighboring communities. International shipments are affected when ports close. Traffic is affected when transportation routes close. Limited work is being done to address building the anticipated economic planning process prior to the event. Forecast and warning would provide important intelligence to the global community and economy.

How Do You Propose Meeting or Complying with This Issue?

- Integrate forecasting and warnings into an economic planning process at the local, regional, and national and international levels.
 - Go beyond work with familiar partners, such as emergency managers and media, to related sectors on a systems approach. As a specific example, work with the Economic Development Administration (EDA) on existing pre-disaster programs at the regional level, and find opportunities to move the FEMA/EDA course on community economic sustainability out into the regions.
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Title: **Precision in Time and Space: Toward More Accurate, Geographically Focused, and Time-sensitive Prediction of Evacuation Rates**

Originator: **Gladwin**

Issue Description:

In storm surge and flood zones, correct evacuation decisions are the final step in a process that translates hurricane forecasts into saving lives. Greater precision in predicting evacuation behavior and its timing is needed, as well as locating the behavior more precisely in areas of highest risk and socioeconomic vulnerability. These same considerations should also be incorporated into immediate wind damage mitigation activity.

Importance:

This would give emergency managers a better idea of where evacuation orders would be followed and where they (and forecasters, the media, etc.) should focus their efforts to improve the communication of forecast information and the risks people face if they do not evacuate. Furthermore, better prediction of evacuation rates also enables better estimation of potential hurricane consequences that depend on evacuation rates, including clearance times, shelter usage, and potential casualty rates. Finally, accurate prediction of the number of casualties avoided through good hurricane forecasts is necessary if we are to calculate the economic value of those forecasts.

How Do You Propose Meeting or Complying with This Issue?

Amplify and coordinate the research currently in process on many fronts and incorporate it into a GIS framework that will enable the spatial coordination of evacuation behavior modeling.

Simulation frameworks for modeling evacuation behavior over time also need to be developed. These will furnish more detailed mechanisms for the operation of temporal decision models at the household level and at the large-scale information flow level. These frameworks could also enable new types of evacuation decision simulations to be constructed in the same manner as expert system programs and model evacuation decisions over time, as new information and constraints get applied to evacuation decision makers. Developing these simulations will require real-time collection of evacuation decision data.

Title: **How Do We Prepare for the Next Hurricane, Not the Last One(s), and How Can We Learn from Other Hazards and Other Places?**

Originator: **Gruntfest**

Issue Description:

What metrics make the most sense for measuring success? Revisit current/old-fashioned methods.

Importance:

Using new products without knowing who will use them or whether they will be used is a waste of resources.

How Do You Propose Meeting or Complying with This Issue?

Support constant ongoing collaborations between private- and public-sector meteorologists, hydrologists, stakeholders, and social scientists.

Title: **Develop an End-to-End-to-End Model of the Hurricane Forecast and Warning System**

Originator: **Lazo**

Issue Description:

A wide variety of methods and approaches are taken to understand specific components of the forecast system. These take on the characteristics of each discipline's approach. An end-to-end-to-end model would integrate these approaches into a comprehensive understanding of the entire process.

Importance:

Because, fundamentally, this is an interdisciplinary problem, finding ways to understand the entire process consistently may lead to significant benefits, as well as to identifying and understanding "gaps."

How Do You Propose Meeting or Complying with This Issue?

Hold one-on-one and group interactions between "modelers" and scientists from different disciplines to determine how to integrate their approaches to develop a cross-disciplinary model of the entire system. Of course, recognize that models have different uses and purposes, and may not be fundamentally "integratable."

Title: **Assess the Optimal Allocation of Agency Resources to Hazard Management Actions Using Decision Analysis**

Originator: **Lindell**

Issue Description:

Agencies should decide how to allocate their budgets to existing services and to develop new services to maximize their payoffs. However, it is often unclear how to do this when there are many courses of action whose outcomes are incommensurate and uncertain.

Importance:

Suboptimal allocation of resources could cost lives unnecessarily. A more cost-effective allocation could produce greater benefits for the same resource investment.

How Do You Propose Meeting or Complying with This Issue?

Decision analysis can address how to invest in various components of long- and short-term forecasts, and vulnerability analysis, given uncertainty about the magnitude of investments in hazard mitigation, emergency preparedness/response, and recovery preparedness/implementation by other federal agencies, state/local governments, and the private sector (i.e., households and businesses). The analysis could define a set of feasible options ranging from ignoring the risk and bearing the losses as they occur (i.e., unplanned recovery) to increasing investments in all of these actions (probably the most sustainable, but certainly the most expensive). However, it also should address uncertainties about the likelihood of different payoffs – reductions in physical (e.g., casualties and damage) and social (e.g., psychological, demographic, economic, and political) impacts – and attitudes toward risk (i.e., the potential for catastrophic outcomes). The decision analysis should construct a decision tree that integrates the decision options, uncontrollable events, and consequences of those uncontrollable events.

Title: **Optimize Warning Area and Lead Time**

Originator: **Willoughby**

Issue Description:

It is clear that, for a given forecast accuracy, it is possible to warn a larger area earlier or a smaller area later. This lead-time versus scope of warning dichotomy reflects a trade-off where there may well be an optimum strategy that reflects the costs of responding to warnings and human/material casualties prevented.

Importance:

It will answer the question, “Is the present practice optimal or suboptimal?”

How Do You Propose Meeting or Complying with This Issue?

Solicit proposals.

Optimize the Understanding of Forecast and Warning Messages to Ensure Optimal Responses from the Message Recipients

Originators:

Gaynor on behalf of himself, Marks, McDonald, and Seguin

The following issues were consolidated under the above title:

Title: **Optimize the Understanding of Forecast and Warning Messages to Ensure Optimal Responses from the Message Recipients**

Originator: **Gaynor**

Issue Description:

There is little understanding of how the forecast and warning messages are received by the public and private sectors that might be at risk. Currently, NOAA does not have an organized, formalized, and informed process to test how its messages are received and to work with the recipients in an iterative fashion to optimize desired responses to its message. The challenge to this process is that the recipients are public sector professionals (e.g., emergency managers), law enforcement, public health officials, and the general public (representing cultural and ethnic diversity).

Importance:

This issue is of fundamental important to NOAA, given its mission to protect lives and property and to protect the general and economic welfare of society. In addition, NOAA is being asked to measure its performance in social and economically relevant ways, such as by using measures of decreased mortality, injuries, and damage. An optimal response among those at risk is critical for the improvement of these performance measures or even to set a baseline.

How Do You Propose Meeting or Complying with This Issue?

The issue of optimal response requires several areas of expertise that NOAA currently does not possess. Among the expertise required is cognitive psychology. Social scientists are needed with expertise in communication within and between cultural and ethnic sectors. Economists are needed to describe expected responses that will lead to decreased economic impacts. A definitive program to measure and develop optimal responses needs to be established and implemented. The plans for such a program could be obtained as a result of competitive solicitation and could require a multidisciplinary approach.

Title: **Warning/Forecast Content Usefulness (Utility)**

Originator: **Marks**

Issue Description:

Much of the content in the warning/forecast advisories try to convey specific information about the storm to elicit a response from the public. However, the content is based on measures/metrics (e.g., latitude, longitude, and peak wind) that have been historically derived. Are the advisories providing useful information or not? Does the public understand what they mean? Are there others that would be more useful? We need a mechanism to develop meaningful forecast/warning content. Meteorologists tend to stick to measures/metrics that we can observe or compute.

Importance:

The purpose of a forecast is to convey information to elicit a specific response. If the information being conveyed by hurricane warnings and forecasts is not useful or does not convey the correct information, then the public will not respond in the needed/desirable manner. Now we rely on education to ensure the public understands what we mean. How do we convey risks from different impacts on the public (i.e., wind, surge, freshwater flood, and/or severe weather [e.g., tornado])? These factors are more important in different parts of the region affected by the storm.

How Do You Propose Meeting or Complying with This Issue?

Review the information in warning/forecast content for usefulness to ensure it conveys the appropriate information. For example, it is difficult to convey information about storm intensity and size with the current metrics (e.g., peak wind and wind radii) so that the public understands risks and desired response. We may need to change the information we provide.

Title: **Why Is a 5-day Forecast Made? Who Decides What Information Is in Forecasts/Warnings, and Why?**

Originator: **Marks**

Issue Description:

Forecast/warning products are decided upon without a large amount of input from different users. Why are certain products chosen, and how can others affect the decision-making process? If some products provide less meaningful information, why do we provide them?

Importance:

The use of information in forecast/warning systems must be evaluated against measures other than meteorological skill/accuracy. If customers do not see the value in a forecast/warning product, we need to evaluate their needs in product selection.

How Do You Propose Meeting or Complying with This Issue?

- Review and revise the process to develop a product suite, evaluate its use, and develop a revised suite.
- Include psychologists, sociologists, and economists in the process more directly.
- Determine if information be conveyed just because we have more information.

Title: **Analyze the Current and Evolving State of Health and Hurricane Knowledge in the Semantic Web for Improving the Strategic Value of Hurricane-related Health Research and Risk Communication**

Originator: **McDonald**

Issue Description:

All human thought and behavior that is represented on the Web is now being dynamically tracked in taxonomies. By using the semantic Web, we can analyze the clustering of ideas in research and in common communication about hurricane risk.

Importance:

To track the hurricane knowledge base and how evidence-based communication is reaching different groups of the public.

How Do You Propose Meeting or Complying with This Issue?

Embed a semantic Web reflector focused on the health impacts of hurricanes within a disaster knowledge management system accessible to collaboration among the hurricane research community.

Title: **We Are Not Making Maximum Use of the Data and Information Integration Capabilities of Today's Technology**

Originator: **Seguin**

Issue Description:

Television and the Internet provide us opportunities for whole new ways of communicating hurricane forecast and response information. This information could be a combination of meteorology, emergency planning, structural engineering, and geography.

Importance:

Improved hazard and hazard mitigation need to be increasingly refined as populations and infrastructure increase to maximize emergency planning and responses.

How Do You Propose Meeting or Complying with This Issue?

Develop strong research programs and facilitate the research community's ability to seek government agency funding.

Precision Versus Accuracy: Are Risks Adequately Expressed by Current Deterministic Forecasts?

Originators:

Green on behalf of himself, Kiser, Laing, Lazo, and Sharp

The following issues were consolidated under the above title:

Title: **Precision Versus Accuracy: Are Risks Adequately Expressed by Current Deterministic Forecasts?**

Originator: **Green**

Issue Description:

Does being precise give a false sense of accuracy? On its own, a deterministic hurricane forecast has the potential to be misleading without supporting qualifying data or caveats. Would probabilities or other/additional forms of information be a better way to communicate risk? Social science needs to research how to best maximize the proper response to a hurricane threat.

The core of this issue is to evaluate if it is appropriate to move away from deterministic to probabilistic or categorical forecasts. If we do move to less deterministic forecasts, how do we communicate this most effectively to our customers (e.g., the public and decision makers) and maximize the proper response to change the outcome?

Does research support this postulation? Do people respond better to a precise forecast that is not necessary accurate, or would they be better served with one that foregoes precision for reasonable accuracy? Are categorical forecasts (i.e., neither deterministic nor probabilistic) a better choice?

Importance:

The issue of precision versus accuracy is important because we want customers to take appropriate actions based on the information and threat that they perceive. How do we change the outcome? We change it by providing our customers with the information to make good decisions.

How Do You Propose Meeting or Complying with This Issue?

Conduct focus groups and surveys. Can we look to the advertising community?

Title: Will Probabilistic Wind Forecasts Be a Valuable Tool for Users?

Originator: Kiser

Issue Description:

The NWS is moving toward deterministic forecasts out to day 7. The forecast includes hurricane winds. Significant errors, however, are inherent in longer forecasts. Probabilistic forecasts are common for precipitation, but not so for wind. Probabilistic tropical cyclone winds will be experimentally introduced this year. What is not known is the value of this product.

Importance:

Probabilistic forecasts are expanding. Let us find out early if these are of any use. Learning the value of probabilistic forecasts applies not only to hurricane programs, but also to many weather products.

How Do You Propose Meeting or Complying with This Issue?

- Surveys.
- Interviews.
- Focus groups.

Title: **Education and Training of Emergency Managers in the Use of Emerging Forecast Products and Observation Products**

Originator: **Laing**

Issue Description:

- Do we know how much continuing education is required for emergency managers?
- How up-to-date do they have to be in the state of hurricane science?
- The use of ensemble forecasts is increasing.
- Do emergency managers know what ensemble forecast products represent?
- How do these new products affect their confidence in the forecasts?
- Emergency managers will be adding this information to their decision-making system anyway.

Importance:

As more products are being “enhanced” and published in the Web, some emergency managers will be using other representations of forecast products to make decisions. They need some basic understanding of what those products really represent.

How Do You Propose Meeting or Complying with This Issue?

- Provide more training in the use of ensemble and probabilistic forecast products.
- Strengthen partnerships.
- Involve COMET, FEMA, universities, and state/local emergency managers.

Title: **Uncertainty**

Originator: **Lazo**

Issue Description:

There is little end-to-end understanding of how uncertainty information is developed, communicated, and used by forecasters, communicators, and decision makers. This applies to various aspects of hurricane forecasts, including track and intensity, as well as precipitation, wind field, and storm surge.

Importance:

Without understanding how individuals use forecast information, it is not possible to understand how best to improve forecasts. Uncertainty is a major component of hurricane forecasts, and thus it is critical to understand how uncertainty is developed, communicated, perceived, understood, acted upon, and valued.

How Do You Propose Meeting or Complying with This Issue?

An end-to-end approach is needed to identify sources of uncertainty, communication of uncertainty information, perception of and response to this aspect of hurricane forecasts, and values for better information on uncertainty of forecasts. Combining meteorological modeling, verification measures, communication, mental modeling, decision modeling, and valuation would fulfill this research.

Title: **Accountability: It Is in Color, and It Animates, So It Must Be Right**

Originator: **Sharp**

Issue Description:

The NWS, through the Weather Forecast Office (WFO), produces gridded forecasts every day of the week. Alone, gridded deterministic-only forecasts (e.g., tropical cyclone winds) do not offer decision makers all vital information (even though it is in color, it animates, and has “implied” skill). WFO provides primary refinement and interpretation of National Center forecasts and

warnings to smartly translate synoptic scale, storm-relative science information into mesoscale, geo-relative service information. A medium is needed to provide probabilistic and threat index information for all associated tropical cyclone hazards.

Importance:

- To satisfy the demand for local information.
- To answer the question, “What is the associated threat of a given tropical cyclone to the local area, not just the projected landfall location; perhaps answering sophisticated users (e.g., emergency managers) and unsophisticated users (e.g., households) alike, at any given time (i.e., changing threat)?

How Do You Propose Meeting or Complying with This Issue?

- Introduce complementary information to include both deterministic and probabilistic information. Will the public understand probabilities?
- Create “threat index” information (e.g., graphical and gridded) based on trended (i.e., interval) forecast magnitude/severity and likelihood of occurrence to feed a hierarchical decision support system(s).
- Employ WFO expertise, Web-based risk, and vulnerability tool teamed with an event tool for situational threats (by hazard).

Coordinated Research Designs and Methodological Improvements in Evacuation Behavior Research

Originators:

Cutter on behalf of herself, Gladwin, and Morrow

The following issues were consolidated under the above title:

Title: **Forecast Error and Evacuation Behavior**

Originator: **Cutter**

Issue Description:

Social science research shows that residential compliance with evacuation orders is a function of past experience, storm intensity, landfall locations, and risk perception, among other factors. We know very little about the relationship between the uncertainty of the forecast information and evacuation behavior. We also know little about the visualization of the forecast information and how its communication (i.e., the form of the risk message) to the public influences evacuation behavior. What form of communication (e.g., text, graphics, and satellite images) provides the most salient information to households as they make evacuation decisions?

Importance:

More than half of the U.S. population lives in coastal counties. Improvements in risk communication and risk visualization could assist in reducing the cost of evacuations and in the selective targeting of residents most at risk. It could also improve some of the utility of forecast products.

How Do You Propose Meeting or Complying with This Issue?

- This requires retrospective studies of previous evacuation decision making and behavior, and its relationship to forecast error and uncertainty.
 - Better sharing and integration of household response data would be helpful (something that is not done now).
 - A national clearinghouse for pre- and post-evacuation studies would be a useful first step. This archive could provide standardized cataloging of behavioral surveys with all the appropriate confidentiality provisions. The archive would be geo-referenced and include the codebooks, survey design, and other metadata. Ideally, it would also be web-accessible to researchers (but may need password access to comply with privacy protections of the respondents). This archive would go a long way toward improving our understanding of evacuation responses, beyond the localized (and sometimes unavailable) data that currently exist, and its relationship to forecast errors and uncertainties.
-

Title: **Evacuation Distances**

Originator: **Cutter**

Issue Description:

There has been a noticeable increase in the distances traveled by coastal evacuees. It is unclear whether this is due to destination choices (e.g., preferences for homes of friends and family, availability of hotel/motel rooms) or the use of distance as a modifier of the threat. These longer journeys put increasing demands on infrastructure (e.g., roads, fuel, etc.) and complicate the emergency management response, as was seen in Hurricane Floyd. In some instances, coastal evacuees actually put themselves in greater danger due to inland flooding. Why has evacuation distance increased over time, and what factors are contributing to it?

Importance:

We need to reduce the column of traffic and non-target population responses during hurricane events. Understanding the likely destinations of evacuees will improve the pre-impact planning for evacuation response, in terms of routes taken, demands on fuel, food, water, etc.

How Do You Propose Meeting or Complying with This Issue?

We need pre- and post-evacuation studies of residents to assess their household evacuation decision-making behavior. The sample size should be sufficient to account for socio-demographic and geographic variability among coastal residents. These surveys should be done prior to the hurricane season and, in the event of a landfall, affected residents should be re-surveyed to compare their anticipated behavior with what they actually did.

Title: **Precision in Time and Space: Toward More Accurate, Geographically Focused, and Time-sensitive Prediction of Evacuation Rates**

Originator: **Gladwin**

Issue Description:

In storm surge and flood zones, correct evacuation decisions are the final step in a process that translates hurricane forecasts into saving lives. Greater precision in predicting evacuation behavior and its timing is needed, as well as locating the behavior more precisely in areas of highest risk and socio-economic vulnerability. These same considerations should also be incorporated into immediate wind damage mitigation activity.

Importance:

This would give emergency managers a better idea of where evacuation orders would be followed and where they (and forecasters, the media, etc.) should focus their efforts to improve the communication of forecast information and the risks people face if they do not evacuate. Furthermore, better prediction of evacuation rates also enables better estimation of potential hurricane consequences that depend on evacuation rates, including clearance times, shelter usage, and potential casualty rates. Finally, accurate prediction of the number of casualties avoided through good hurricane forecasts is necessary if we are to calculate the economic value of those forecasts.

How Do You Propose Meeting or Complying with This Issue?

Amplify and coordinate the research currently in process on many fronts and incorporate it into a GIS framework that will enable the spatial coordination of evacuation behavior modeling.

Simulation frameworks for modeling evacuation behavior over time also need to be developed. These will furnish more detailed mechanisms for the operation of temporal decision models at the household level and at the large-scale information flow level. These frameworks could also

enable new types of evacuation decision simulations to be constructed in the same manner as expert system programs and model evacuation decisions over time, as new information and constraints get applied to evacuation decision makers. Developing these simulations will require real-time collection of evacuation decision data.

Title: **Establish Protocols for Evacuation Studies**

Originator: **Morrow**

Issue Description:

Most evacuation research today consists of event-specific, basic surveys that are not submitted for peer review. This makes it impossible to do meta-research and to develop a body of systematic data and findings that can be used to improve future evacuations.

Importance:

The present system is simplistic and wasteful. Most post-event evacuation research being done does not take advantage of GIS and other technologies. Funding is typically delayed, and thus much data is lost or skewed.

How Do You Propose Meeting or Complying with This Issue?

- Conduct a national workshop of evacuation researchers to assess the state of the work and establish protocols.
- Establish a national repository of evacuation studies.
- Develop strategies for promoting rapid funding for pre-event, real-time, and immediate post-event surveys.

Decision Making by Local Emergency Management Agencies

Originators:

Peacock on behalf of himself, Laing, Lindell, and Prater

The following issues were consolidated under the above title:

Title: **Decision-making by Local Emergency Management Agencies**

Originator: **Peacock**

Issue Description:

- Research the decision-making processes at the local emergency management level.
- Better understand how NWS products are employed by local emergency management; what factors shape the decision-making process; and, how cost and losses are evaluated by emergency management.

Importance:

Ultimately, evacuation decisions are made or driven by local emergency management – we need to better understand the very different environments in which these decisions are made and how NWS products are used.

How Do You Propose Meeting or Complying with This Issue?

This research agenda will demand that both qualitative and quantitative methods and techniques (e.g., detailed case study and broader comparative survey work) be employed.

Title: **Education and Training of Emergency Managers in the Use of Emerging Forecast Products and Observation Products**

Originator: **Laing**

Issue Description:

- Do we know how much continuing education is required for emergency managers?
- How up-to-date do they have to be in the state of hurricane science?
- The use of ensemble forecasts is increasing.
- Do emergency managers know what ensemble forecast products represent?
- How do these new products affect their confidence in the forecasts?
- Emergency managers will be adding this information to their decision-making system anyway.

Importance:

As more products are being “enhanced” and published in the Web, some emergency managers will be using other representations of forecast products to make decisions. They need some basic understanding of what those products really represent.

How Do You Propose Meeting or Complying with This Issue?

- Provide more training in the use of ensemble and probabilistic forecast products.
- Strengthen partnerships.
- Involve COMET, FEMA, universities, and state/local emergency managers.

Title: “I have 20 Years of Hurricane Training and Experience, but My Brand New Mayor Wants to Make the Evacuation Decision”

Originator: Lindell

Issue Description:

Local elected officials, emergency managers, and transportation and land-use planners must make and implement protective action decisions that are difficult, infrequent, and critical. Little or nothing is known about how they define the problem and collect or process relevant information.

Importance:

Local officials are an important source of information about the severity of the hurricane threat, and support for the implementation of evacuation transportation and traffic management is needed.

How Do You Propose Meeting or Complying with This Issue?

Develop multi-method assessment using semi-structured protocols, cognitive mapping, and response to hurricane simulations.

Title: Economic and Political Costs of Evacuation for Local Governments

Originator: Prater

Issue Description:

Local governments face an evacuation dilemma. If they evacuate and no hurricane comes, they face management costs for the evacuation that will not be reimbursed by the federal government. For small jurisdictions, these costs can be a significant issue, displacing spending for other needs. How do local governments deal with these expenditures? How do they affect future willingness to request/order evacuation? Are local governments aware of this risk? Do they face political consequences in cases where these expenditures become a drag on their budgets?

Importance:

Local governments are under increased financial pressure. They have few extra resources, and federal sources like Community Development Block Grants are under threat. They need to be able to protect their people without fear of bankruptcy or political punishment for using their best professional judgment.

How Do You Propose Meeting or Complying with This Issue?

- Review applications for Presidential Disaster Declarations. Compare the costs of the applications granted and those not granted, as a proportion of local government budgets. Do larger communities get more Presidential Disaster Declarations than smaller communities (proportionately)?
 - Conduct theoretically based configurative case studies of evacuations in communities of varying sizes for varying categories of hurricanes. Examine the political consequences, if any, of unreimbursed evacuation expenditures.
-

Title: **Use NWS Staff and Products to Change the Framing of Hazard Adjustments**

Originator: **Prater**

Issue Description:

Hazard adjustments, such as strict building codes and land-use planning/zoning, are usually framed in terms of their costs: more expensive construction, more expensive land (because the supply is reduced through hazard zoning), etc. We need to change the focus to the benefits of hazard adjustments for individuals, businesses, and local/state/federal governments. Local NWS offices are ideally placed to serve as policy entrepreneurs for this change of focus. Among the benefits to be highlighted is the reduced loss of housing stock, lower insurance premiums, reduced damage to infrastructure, less time at work lost to repairing businesses and homes, etc.

Importance:

Issue framing dominates the public discussion of any policy. By changing the frame, we can change the policy outcome. If you doubt me, ask the heirs of Lee Atwater.

How Do You Propose Meeting or Complying with This Issue?

- Interaction between local NWS offices with planners, city managers, businesses, and civic organizations for the purpose of issue framing.
- Develop a series of talking points emphasizing the periodicity of the hazard, levels of uncertainty, and the use of the precautionary principle in land use and construction decision-making.
- Research the effectiveness of mapping and ways to improve communication of risk areas.

Evacuation Response Issues

Originators:

Beven on behalf of himself, Cutter, Green, Leatherman, Letson, Sutter, and Willoughby

The following issues were consolidated under the above title:

Title: **Evacuation Response Issues**

Originator: **Beven**

Issue Description:

A significant number of people who need to evacuate during a hurricane do not. Others who do not need to evacuate do (this is the shadow evacuation problem). How can a greater and/or more efficient response be brought about? Is there a limit on how many people can be convinced to evacuate?

Importance:

The number of people evacuated will determine how many people will be left in harm's way.

How Do You Propose Meeting or Complying with This Issue?

Research is needed to determine the "whys" of evacuation, as well as how to make the "get out now" message more effective. Is the message of "flee from the storm surge and hunker down from the wind" effective and/or correct?

Title: **Evacuation Distances**

Originator: **Cutter**

Issue Description:

There has been a noticeable increase in the distances traveled by coastal evacuees. It is unclear whether this is due to destination choices (e.g., preferences for homes of friends and family, availability of hotel/motel rooms) or the use of distance as a modifier of the threat. These longer journeys put increasing demands on infrastructure (e.g., roads, fuel, etc.) and complicate the emergency management response, as was seen in Hurricane Floyd. In some instances, coastal evacuees actually put themselves in greater danger due to inland flooding. Why has evacuation distance increased over time, and what factors are contributing to it?

Importance:

We need to reduce the column of traffic and non-target population responses during hurricane events. Understanding the likely destinations of evacuees will improve the pre-impact planning for evacuation response, in terms of routes taken, demands on fuel, food, water, etc.

How Do You Propose Meeting or Complying with This Issue?

We need pre- and post-evacuation studies of residents to assess their household evacuation decision-making behavior. The sample size should be sufficient to account for socio-demographic and geographic variability among coastal residents. These surveys should be done prior to the hurricane season and, in the event of a landfall, affected residents should be re-surveyed to compare their anticipated behavior with what they actually did.

Title: **Do People Evacuate Because Elected Officials Say So?**

Originator: **Green**

Issue Description:

Do people evacuate because a local official tells them to? Do the people that evacuate reach this decision gradually, or like a switch (when called for, they act)?

What are the cues to begin preparations? Do people look to local officials for these cues or do people conduct a self-evaluation to determine their own vulnerability?

Importance:

It is important to determine these triggers to fine tune how we communicate the message to maximize the response.

How Do You Propose Meeting or Complying with This Issue?

Conduct surveys and focus group meetings.

Title: **Real-Time, 3-D Visualizations of Hurricane Storm Surges and Risk Communication: Implications for Evacuation**

Originator: **Leatherman**

Issue Description:

Research shows that many people do not respond to hurricane warnings (e.g., during Hurricane Georges in the Florida Keys, only 50 percent of the affected population evacuated). Forecasts of so many feet of water rise and even maps do not make the warning seem real or understandable to many people (e.g., this is the Television generation).

Importance:

There is the potential for thousands of people to drown because they do not understand the threat (e.g., even if people knew their elevation, they have little idea of how to translate a forecast of 5 to 10 feet of water to their home). My doctor friend in Miami has his own warning system: ocean water topping his seawall and sharks in the swimming pool. On the other hand, there is too much over-evacuation, which is clogging the highways. People need to hide from the wind and flee from water. This was particularly evident during Hurricane Floyd, when 3-million people got into their cars and tried to get out of town.

How Do You Propose Meeting or Complying with This Issue?

Build collaboration among geographers using GIS/computer animation and other social scientists involved with risk communication.

Title: **What Is the Value of Contraflow?**

Originator: **Letson**

Issue Description:

One way to increase forecast value is by increasing the ease or range of forecast responses. More endangered people will evacuate if it is easier to do so. On the other hand, contraflow is labor intensive and brings its own risks. When does contraflow make sense?

Importance:

Calls for estimating forecast value are most helpful when they encourage us to think about the variety of ways that the forecast process might be improved. If too broadly defined, forecast value is meaningless. Contraflow has not received enough study and may be critical for congested and vulnerable places like New Orleans and Miami.

How Do You Propose Meeting or Complying with This Issue?

Develop a random utility model (e.g., travel cost) of evacuation choices. This would provide estimates of the value of contraflow on interstate highways.

Title: **Does Evacuation from an Approaching Hurricane Benefit Residents, and Can We Demonstrate the Benefit?**

Originator: **Sutter**

Issue Description:

Construct an expected utility model to address whether evacuation raises an individual resident's expected utility. The probability that a resident would be killed or injured by not evacuating would be required for this calculation. Can these probabilities be estimated? The probability of a fatality should depend on the quality of a resident's housing, its exact location, and the expected intensity of the hurricane.

Importance:

The exercise could yield a better understanding of why people in threatened areas do not evacuate and why residents outside the evacuation area do evacuate. This knowledge could help reduce casualties and avoid excessive evacuation costs. This work could also illustrate differences in the decision calculus of at-risk populations compared to the medium resident. The expected utility theory will not provide the only answer to these questions, but will also provide an important start.

How Do You Propose Meeting or Complying with This Issue?

Data on fatalities by location (county) during hurricanes would be necessary and probably available from the NHC. Emergency managers would probably need to supply estimates of how many people evacuated to infer how many were actually in the hurricane's path.

Title: **Are We Evacuating the Right People?**

Originator: **Willoughby**

Issue Description:

Timely evacuation from the surge zone is the strategy that reduced hurricane mortality by 90 percent. Clearly, we are removing humans from harm's way. But are we also spending extravagantly to remove them from discomfort's way or anxiety's way? We need to reassess criteria for evacuation. Ankle-deep water is not a hazard to life, except for toddlers and quadriplegics.

Importance:

If we can substantially reduce the scope of evacuation, we can prevent a great deal of unnecessary expense and disruption.

How Do You Propose Meeting or Complying with This Issue?

- Study what actually happens in both the surf zone and in areas where still water rises.
- Solicit proposals.

Determine the Economic Cost of Evacuations ("Why you don't want to be on Bourbon Street next Tuesday.")

Originators:

Lazo on behalf of himself, Lindell, and Prater

The following issues were consolidated under the above title:

Title: **Determine the Economic Costs of Evacuations ("Why you don't want to be on Bourbon Street next Tuesday.")**

Originator: **Lazo**

Issue Description:

The socioeconomic costs of evacuations are specific to the spatial and temporal characteristics of evacuation. No "cost-per-mile" estimate can be considered meaningful. Economically valid and reliable estimates or models of evacuation costs are important for decision making on research investments and for evacuation decision makers.

Importance:

The cost of evacuation and the avoided cost of not evacuating are key arguments for improving hurricane forecasts, yet there are no valid estimates of these costs. It is important to have valid, reliable economic estimates of the cost of evacuation for making appropriate forecast improvement investments.

How Do You Propose Meeting or Complying with This Issue?

A variety of methods for modeling and estimating the economic costs of evacuation could be used. First, a theoretically correct definition of evacuation costs should be developed. A wide

sample survey of households and businesses could estimate costs *ex ante*. Post-hurricane surveys of evacuees and non-evacuees could provide case studies for validation.

Title: Estimate the Cost of Business Evaluation

Originator: Lindell

Issue Description:

Local officials hesitate to initiate an evacuation in part because of the costs to households, businesses, and government agencies. In the absence of accurate information, they might overestimate these costs (depressing the likelihood of evacuations) or underestimate them (increasing unnecessary evacuations). Data on costs to households and government agencies are becoming available, but costs to businesses are problematic because these social units are more variable in size and technology than households. Moreover, businesses differ among themselves in terms of the permanence of business losses. For example, restaurant sales will be lost whereas sales of durable goods will probably just be deferred.

Importance:

Concerns about business costs of evacuation could cause delays in the initiation of evacuations.

How Do You Propose Meeting or Complying with This Issue?

Survey research by size of business and Standard Industrial Code.

Title: Economic and Political Costs of Evacuation for Local Governments

Originator: Prater

Issue Description:

Local governments face an evacuation dilemma. If they evacuate and no hurricane comes, they face management costs for the evacuation that will not be reimbursed by the federal government. For small jurisdictions, these costs can be a significant issue, displacing spending for other needs. How do local governments deal with these expenditures? How do they affect future willingness

to request/order evacuation? Are local governments aware of this risk? Do they face political consequences in cases where these expenditures become a drag on their budgets?

Importance:

Local governments are under increased financial pressure. They have few extra resources, and federal sources like Community Development Block Grants are under threat. They need to be able to protect their people without fear of bankruptcy or political punishment for using their best professional judgment.

How Do You Propose Meeting or Complying with This Issue?

- Review applications for Presidential Disaster Declarations. Compare the costs of the applications granted and those not granted, as a proportion of local government budgets. Do larger communities get more Presidential Disaster Declarations than smaller communities (proportionately)?
- Conduct theoretically based configurative case studies of evacuations in communities of varying sizes for varying categories of hurricanes. Examine the political consequences, if any, of non-reimbursed evacuation expenditures.

PRIORITY 12

Determine the Most Appropriate Training, Tools, and Educational Materials (and the Most Efficient Delivery Systems) for At-risk Populations

Originators:

Massey on behalf of himself and Laing

The following issues were consolidated under the above title:

Title: **Determine the Most Appropriate Training, Tools, and Educational Materials (and the Most Efficient Delivery Systems) for At-risk Populations**

Originator: Massey

Issue Description:

The training and education of ever-increasing coastal populations, including emergency management and decision makers, are critical needs.

Importance:

The possibility of a major loss-of-life disaster continues to increase with the likelihood of increased hurricane activity in the coming years and the certainty of an increase in the at-risk populations in coastal areas.

How Do You Propose Meeting or Complying with This Issue?

- Develop a series of education/training tools and materials, many targeted at school-age children, to set the stage for better responses to the threat of future storms.
- COMET, NWS, and FEMA could support this issue.

Title: **Improve Public Education and Awareness That Inland Flooding Is a Major Hazard of Tropical Disturbances**

Originator: **Laing**

Issue Description:

Improving public education and awareness (health, safety, and hurricane knowledge) will reduce deaths from flooding due to tropical disturbances. Social science research on other flood warnings systems (e.g., flash floods) can be applied to tropical cyclones.

Importance:

Deaths from inland flooding are the leading cause of deaths in the past three decades in the U.S.

How Do You Propose Meeting or Complying with This Issue?

- Examine the reasons for success in storm surge education. For example, what has been the role of the surge maps? Could there be a system of maps showing the inundation in the neighborhoods of:
 - 1 in/hr of rainfall over 6 hours and over 12 hours
 - 2 in/hr of rainfall over 6 hours and over 12 hours
- Underlying map – dry.
- Underlying map – saturated.
- Education video clips and/or television spots showing rising water inland.
- More proposals:
 - placement of signs along roadways (e.g., high water marks on light poles; “Turn Around/Don’t Drown” billboards)
 - gates at underpasses that are susceptible to flooding

Mitigation Versus Evacuation: How to Reframe the Issues in Decision-Maker Parlance

Originators:

Leatherman on behalf of himself, Gladwin, Letson, and Simmons

The following issues were consolidated under the above title:

Title: **Mitigation Versus Evacuation: How to Reframe the Issues in Decision-Maker Parlance**

Originator: **Leatherman**

Issue Description:

- Formulate the costs of mitigative actions versus the cost of over-evacuation.
- Need real costs in economic and social terms, in order to make more informed decisions.
- Need to show the linkage and relative costs for mitigation versus evacuation.

Importance:

There is too much over-evacuation and, at the same time, it is difficult to “sell” mitigative actions (i.e., the upfront costs). For instance, Florida’s hurricane swarm of 2004 caused \$42 billion in damage, and Congress has authorized \$15 billion in supplemental post-hurricane impact funding, but nearly all the money is for response and recovery rather than mitigative actions. The legislators want to put all the money “in the ground” and in their damaged congressional districts, which is understandable politically. Very little funding will be made available for true mitigative actions and even less for mitigative research.

How Do You Propose Meeting or Complying with This Issue?

By linking the costs of mitigation and evacuation, a much better case can be made for mitigation, including mitigative research. This is a major multidisciplinary research agenda. These issues need to be properly framed so that they can be addressed and not just merely discussed in forums like this workshop.

Title: **Add and Determine Human Housing Loss as a Measure of Hurricane Casualties**

Originator: Gladwin

Issue Description:

Negative hurricane effects are typically assigned to be either casualties (i.e., death and injury to people) or property losses. We need to add loss of housing as a separate category from death and injury. Recent hurricanes, particularly those affecting Florida last year, have had very low death and injury rates. And yet, long-term human losses are clearly going to be very high. The major reason is that a large number of people are finding it very difficult to obtain the level of housing they had before. Most of these people had no insurance to rebuild or buy new housing, or they lived in mobile homes or other low-cost housing that will not be replaced at a cost level they can afford. The situation is exacerbated by the fact that the most hurricane-prone areas (i.e., coastal zones and southern States) are areas where property values are increasing most rapidly.

Importance:

Housing is a basic human need, and the long-term loss of adequate secure housing, located where income-earning activity is possible, is clearly one of the significant human casualties resulting from hurricanes.

How Do You Propose Meeting or Complying with This Issue?

- The long-term housing loss from hurricanes has to be measured and compared with the long-term housing loss from other processes, such as redevelopment and gentrification.
- More wind-engineering research is needed to focus on structures that provide low-income housing.

- Social science research is needed to further measure the extent of hurricane-related long-term housing loss.
- Research on mitigation behavior (e.g., shuttering to protect the home envelope, flood protection, etc.) is needed to focus on activities required as a hurricane approaches, to determine ways to translate hurricane forecasts (particularly inland) into emergency management policies and behavior that will save homes.

A considerable amount of research on these topics has been done in Florida by NSF-funded research on the effects of Hurricane Andrew and a Florida Department of Community Affairs-funded survey of home mitigation behavior. This type of work needs to be accelerated and merged into a more comprehensive forecast-emergency management process, as done in the research of Mike Lindell (TAMU) and his colleagues.

Title: **“I Have Storm Shutters, So I Am Staying Put”**

Originator: **Letson**

Issue Description:

How do evacuation responses affect the efficacy of mitigation, and vice versa? Society can select its level of hurricane risk avoidance through a mixture of mitigation and evacuation. Seldom has anyone considered how the interplay between mitigation and evacuation affects the level of risk and the cost of risk reduction. In other words, how do small changes in mitigation affect the productivity of evacuation, and vice versa?

Importance:

Fragmentary thinking can be counter-productive. The assumed separability of mitigation and evacuation is both misleading and commonplace. This artificial separation carries over to the research agenda, where investments into the behavioral component of hurricane risk reduction have historically been small.

How Do You Propose Meeting or Complying with This Issue?

I will work with Sally Kane (consultant) and interested others to develop an endogenous risk avoidance framework for hurricanes.

Title: **Incentives for Increased Emphasis on Permanent Mitigation**

Originator: **Simmons**

Issue Description:

Find ways, either enforced or voluntary, to get residents to install permanent mitigation on their properties. This can be done through properly enforced building codes and programs to educate residents on the benefits of mitigation.

Importance:

Prepared populations need less time to leave the area.

How Do You Propose Meeting or Complying with This Issue?

Public awareness; insurance incentives; and tax incentives.

How to Include Human and Social Costs in Cost-Benefit Analyses of Better Forecasts and Warnings

Originator:

Morrow

Issue Description:

By limiting value estimates to obvious ones related to insurance payouts, response costs, and business losses, we fail to account for the human and social costs. This is much more complicated and involves studying largely invisible and powerless groups.

Importance:

Unfortunately, adding the hidden human and social costs is not very important to policymakers. A great deal of human suffering and social disruption could be reduced by better understanding the context of people's lives and, thus, by incorporating a more appropriate and timely communication/response to their circumstances and needs.

How Do You Propose Meeting or Complying with This Issue?

- Educate policymakers on the long-term hidden costs.
- Document long-term social costs through field studies, ethnographies, and case studies.
- Encourage the greater use of qualitative methodologies.

“I thought we lived in a democracy”: Protective Action Decision Making by Businesses and Other Formal Organizations

Originators:

Peacock on behalf of himself and Lindell

The following issues were consolidated under the above title:

Title: “I thought we lived in a democracy”: Protective Action Decision Making by Businesses and Other Formal Organizations

Originator: Peacock

Issue Description:

- We need to better understand the factors that influence Protective Action Decision Making, especially with respect to employee release and closing in response to hurricane warnings and forecasts. How do these differ for different types of business organizations?
- We need to understand warning perception and preparation timing issues.
- How do NWS’ predictions factor into decision making?
- How do decisions by business leaders/management facilitate and/or thwart employee warning and preparation timing?

Importance:

- Decisions by businesses and local government greatly influence the response possibilities of both individuals and households.
- Decision and choices are not equal. The decisions by some organizations have large impacts on a community's populations.

How Do You Propose Meeting or Complying with This Issue?

Both qualitative and quantitative approaches are necessary.

Title: **Estimate the Cost of Business Evaluation**

Originator: **Lindell**

Issue Description:

Local officials hesitate to initiate an evacuation in part because of the costs to households, businesses, and government agencies. In the absence of accurate information, they might overestimate these costs (depressing the likelihood of evacuations) or underestimate them (increasing unnecessary evacuations). Data on costs to households and government agencies are becoming available, but costs to businesses are problematic because these social units are more variable in size and technology than households. Moreover, businesses differ among themselves in terms of the permanence of business losses. For example, restaurant sales will be lost whereas sales of durable goods will probably just be deferred.

Importance:

Concerns about business costs of evacuation could cause delays in the initiation of evacuations.

How Do You Propose Meeting or Complying with This Issue?

Survey research by size of business and Standard Industrial Code.

How Does the Culture of the Organizations on Both the Sending and Receiving Ends of Forecasting Affect the Ability to Improve?

Originators:

Morrow on behalf of herself and Frew

Title: **How Does the Culture of the Organizations on Both the Sending and Receiving Ends of Forecasting Affect the Ability to Improve?**

Originator: **Morrow**

Issue Description:

Risk communication research has shown how certain types of organizational culture either encourage or impede change. To my knowledge, this paradigm has not been applied to the forecasting and disseminating communities.

Importance:

To improve, we need to understand and acknowledge organizational constraints before we can hope for change.

How Do You Propose Meeting or Complying with This Issue?

Involve fieldwork and case studies in the various NOAA entities involved in forecasting, the (public and private) organizations involved in dissemination and response, and the common institutions, businesses, and households expected to respond.

Title: **They're Big, They're Bad, and They're Scary. Hurricanes? No, Those Who Forecast Them!**

Originator: **Frew**

Issue Description:

Information, education, and an understanding of the world of meteorology are limited. Greater cultural understanding and linkages need to be built between meteorological organizations and working professionals, students, and the civil society. There are huge barriers to moving data/knowledge and research findings into community implementation.

Importance:

Bridges need to be built between the frightening world of bureaucracy of government policymakers, researchers, scientists, civil society, and the everyday world of the potential victim. People learn from experiential learning/face time. Great public relations are created through word of mouth and accessibility.

How Do You Propose Meeting or Complying with This Issue?

- Create internship opportunities for students, community-based organizations, businesses, and cross-sector representatives to learn and find ways to build bridges. Build on partnership development concepts.
- Draw from experience to build new outreach.

How Do Public and Private Sectors Respond to Potentially Conflicting Forecasts and Warnings?

Originators:

Gaynor on behalf of himself, Beven, and Letson

The following issues were consolidated under the above title:

Title: **How Do Public and Private Sectors Respond to Potentially Conflicting Forecasts and Warnings?**

Originator: **Gaynor**

Issue Description:

As private and university weather forecasting becomes more prevalent, and the various media outlets disseminate these forecasts to the public and private sectors, there is potential conflict between the forecast messages. Although not a particular problem in more benign weather situations, it could prove dangerous to those at risk in potentially hazardous weather situations.

Importance:

The concern is that both the public sector (e.g., emergency managers and law enforcement) and the general public could receive conflicting messages prior to a hazardous weather event. If this is the case, might there be confusion on their part as to how to respond? How do they use this array of forecast information and how can we make this information more understandable to them and, therefore, elicit optimal responses to the hazard?

How Do You Propose Meeting or Complying with This Issue?

There needs to be two steps:

- The first step must involve cognitive psychologists and sociologists who interview representatives of the public and private sectors on how they use this potentially conflicting information.
 - The results of this study should be used at a workshop attended by NOAA agencies, private sector forecasters, and media representatives to discuss this issue and to develop a plan consisting of a methodology to minimize the potential for conflicts in forecast information in potentially hazardous weather situations. Hurricanes could be used as the initial test case. NOAA should take the lead in organizing the workshop. The process could be described, developed, and implemented as a result of a competitive award.
-

Title: **Forecast and Warning Messages – Are They Clear?**

Originator: **Beven**

Issue Description:

While the TPC is the official source of tropical cyclone forecasts, the media and private-sector meteorologists can put whatever interpretation on those forecasts that they like, or publicly make their own forecasts. This potential mixed message could cause confusion among the users of the forecast. Can the private sector be persuaded to work from the same page of the playbook as the public sector?

Importance:

Mixed messages and confusion among the forecast users could delay or prevent necessary responses.

How Do You Propose Meeting or Complying with This Issue?

We need research on:

- Who is the most effective source of information to the public.
- How to get public, private, and media meteorologists to work more effectively together during dangerous weather events.

Title: **Are More Forecasts Better?**

Originator: **Letson**

Issue Description:

The NHC is not the only forecast provider. Increasingly, other information sources and forecast models have become more prevalent and more widely disseminated. We cannot change these trends, but we can try to use them to our advantage.

Importance:

Decision theory supports the notion that discoveries most frequently occur in a decentralized manner. Yet these discoveries (e.g., forecast models) must be evaluated and aggregated to be most useful to decision makers. How can we best collect the wisdom of the growing crowd of forecasters?

How Do You Propose Meeting or Complying with This Issue?

Sound like a good topic for experimental economics.

NHRP—Pronounced “NaHurp”

Originator:

Prater

Issue Description:

Can the National Hurricane Response Program (NHRP) spearhead the development of an issue network as strong as the earthquake network? It has long been noted that hurricanes, as a hazard, do not receive the same amount of funding as earthquakes, which take up a significant amount of the NSF research budget, for example. This is not consistent with the level of risk to life and property that hurricanes represent.

Importance:

An issue network, or advocacy coalition, can promote the importance of hurricanes and other weather-related hazards at the national, state, and local levels. This can lead to an increase in funding by NOAA, NWS, and in other hurricane-related social science research and physical research.

How Do You Propose Meeting or Complying with This Issue?

NWRI, NWS, NHC, and NOAA can start with the participants at this workshop, expand the list, and begin to convene annual meetings. They can lobby NSF and Congress for the creation of a NaHurp to increase the amount of research funding for basic physical and social science research.

PRIORITY 19

Is Education the Best Mitigation?

Originators:

Dash on behalf of herself and Green

The following issues were consolidated under the above title:

Title: Is Education the Best Mitigation?

Originator: Dash

Issue Description:

Recent research on mobile home populations has shown that 20 to 25 percent do not even acknowledge the increased danger to their housing. Anecdotal evidence shows that many others in highly physically vulnerable locations do not see or acknowledge their danger. Hurricane forecasts and warnings can not only be a hurricane-season specific issue. Education must be a constant process (include education on elevation and use visualization).

Importance:

Populations today are highly mobile. Each year, more and more people move into coastal zones. Hurricane education needs to become more institutionalized. This has been done in earthquake areas, yet it does not seem as if it has had the same success or implementation in hurricane zones. Indeed, perhaps one of the things we need to do is expand what people consider the hurricane zone. Hurricanes in Florida in 2004 emphasized that the entire state is at risk, yet many people who live inland do not recognize this danger. People will not take protective measures if they do not recognize the danger.

How Do You Propose Meeting or Complying with This Issue?

- More integrated and required education programs for K-12 students in vulnerable locations are needed. This has worked with other hazards. This education must expand beyond a focus on preparedness. It should include specific education on the hurricane forecast and

warning. If we want people to understand the “cone of probability” that forecasters use, then we have to commit more to education programs. It has to become part of the culture. Consistent, repeated education programs will be key. Using state education requirements may be the way to integrate this into science and other types of curriculum.

- Use experimental designs. For example, educate one group on elevation using 3-D visualization (i.e., here is your house, and this is what a 5-foot storm surge would look like). Then ask questions about evacuation, shutters preparedness, etc. Use control group without the “education” – large sample size so you can also assess socioeconomic considerations.
-

Title: **Indirect Fatalities: How Do We Change This Outcome?**

Originator: **Green**

Issue Description:

Loss of life is loss of life. Three out of four hurricane-related deaths in Florida this past season were indirect fatalities (92 out of 123). In fact, more people died in the process of cleanup than directly from the forces of the storm. What do we need to do to educate the public about this “hazard”? As this is one snapshot of one state and only one year, we need to research this overlooked aspect of hurricanes. For the sake of completeness, also research what fatalities did not occur due to the hurricane.

Importance:

If we do not know how and why people are dying, then we cannot change the outcome.

How Do You Propose Meeting or Complying with This Issue?

The Virginia Medical Examiners Office has done some research. Comb the data and contact state medical examiners.

Incorporate Fundamental Research into Studies of Perception of Forecasts, Individual Decision Making and Response, Communication, and Outreach, across Economic Classes and Cultures

Originator:

Kane

Issue Description:

Research can be enriched using results from fundamental science studies on cognition, visualization, decision sciences, communication, social psychology, risk analysis, etc. Laboratory experiments and field work should be conducted to make use of this exciting science. In turn, this research, drawing more on fundamental science, can be useful for areas outside of hurricane events.

Importance:

Attitudes, decisions, and options vary widely across different populations affected by hurricanes. We need innovative research to unravel the most important phenomena in human reaction to hurricanes and forecast information to best target communication and outreach efforts.

How Do You Propose Meeting or Complying with This Issue?

We need interdisciplinary teams to conduct research across different populations and cultures.

Are We Looking for Our Keys under the Streetlight?

Originators:

Lazo on behalf of himself, McDonald, and Willoughby

The following issues were consolidated under the above title:

Title: Are We Looking for Our Keys under the Streetlight?

Originator: Lazo

Issue Description:

For this workshop, we have brought together a group of people through a process of “mutual” identification. My question is, without prior expectation of a “yes” or “no” answer: “Are we missing any significant (however you want to define significant) people, players, stakeholders, and/or social science researchers (e.g., law, accounting) who would help us answer the workshop question?”

Importance:

If the answer to this question is “yes,” then by definition it is important to bring these aspects/people into our discussion.

How Do You Propose Meeting or Complying with This Issue?

Ask people to think outside the box. Recognize that hurricanes are low-frequency/high-impact events and, therefore, are likely to contain surprises.

Title: **Why Sally Died on Her School Bus: Strategic Emphasis on the Parameters of Catastrophic Failures Based upon Health Indicators**

Originator: McDonald

Issue Description:

These parameters need to be measured across the phases of hurricane disasters:

- Preparedness.
- Forecasting.
- Warning.
- Risk communication.
- Evacuation.
- Response.
- Mitigation.
- Relief.
- Recovery.

The parameters need to be established over time for each subpopulation, with an emphasis on disadvantaged communities.

Importance:

- Large potential loss of life.
- Large human cost.
- Large potential long-term economic damage.

How Do You Propose Meeting or Complying with This Issue?

Construct hurricane disaster knowledge management systems to ensure that each stakeholder group and household understands and rules out potential catastrophic failures based upon current situational awareness.

Title: **Probability of Large Hurricane-related Mortality**

Originator: **Willoughby**

Issue Description:

Arrive at statistically rigorous values for the probabilities of >100, >200, >500, >1000, etc. deaths in a hurricane landfall with present-day forecasting and population.

Importance:

If the probabilities are small (i.e., <0.01), it makes policy sense to rely upon the general advance of the forecaster's art and to prevent a massive human catastrophe. If it is larger, targeted research to identify scenarios and develop forecasting techniques should become a priority for meteorological research.

How Do You Propose Meeting or Complying with This Issue?

- Analyze historical (i.e., twentieth century) data.
- Conduct community-by-community studies of population, clearance times, and forecasting performance.
- There are several individuals and groups within this community who can do these studies. Recommend that future Request for Proposals indicate their desirability.

Is There a Changing Paradigm for Coastal Inhabitants?

Originator:

Beven

Issue Description:

The coastal population is growing faster than our abilities to forecast hurricanes. This has resulted in evacuation clearance times longer than our ability to make precise forecasts. It is compounded by the vulnerability of coastal structures. Can public perception of the hurricane threat be changed in ways that could slow coastal growth to manageable levels and reduce structural vulnerability?

Importance:

A changed perception of the hurricane threat and its associated costs could lead to changes in the management of coastal development. This, in turn, could lead to decreased coastal damage through appropriate mitigation programs and could lead to decreased population at risk.

How Do You Propose Meeting or Complying with This Issue?

Research is needed on what would change the general perception of the hurricane threat and evoke a better general response.

STRENGTH OF FEELING ANALYSIS

The Strength of Feeling Analysis is a method that gives a quantitative sense – expressed as a percentage – of the degree of agreement, or disagreement, among the participants regarding the importance of each identified issue.

Table 1 is organized according to the priority ranking by all 30 participants of the 22 major issues on which they voted.

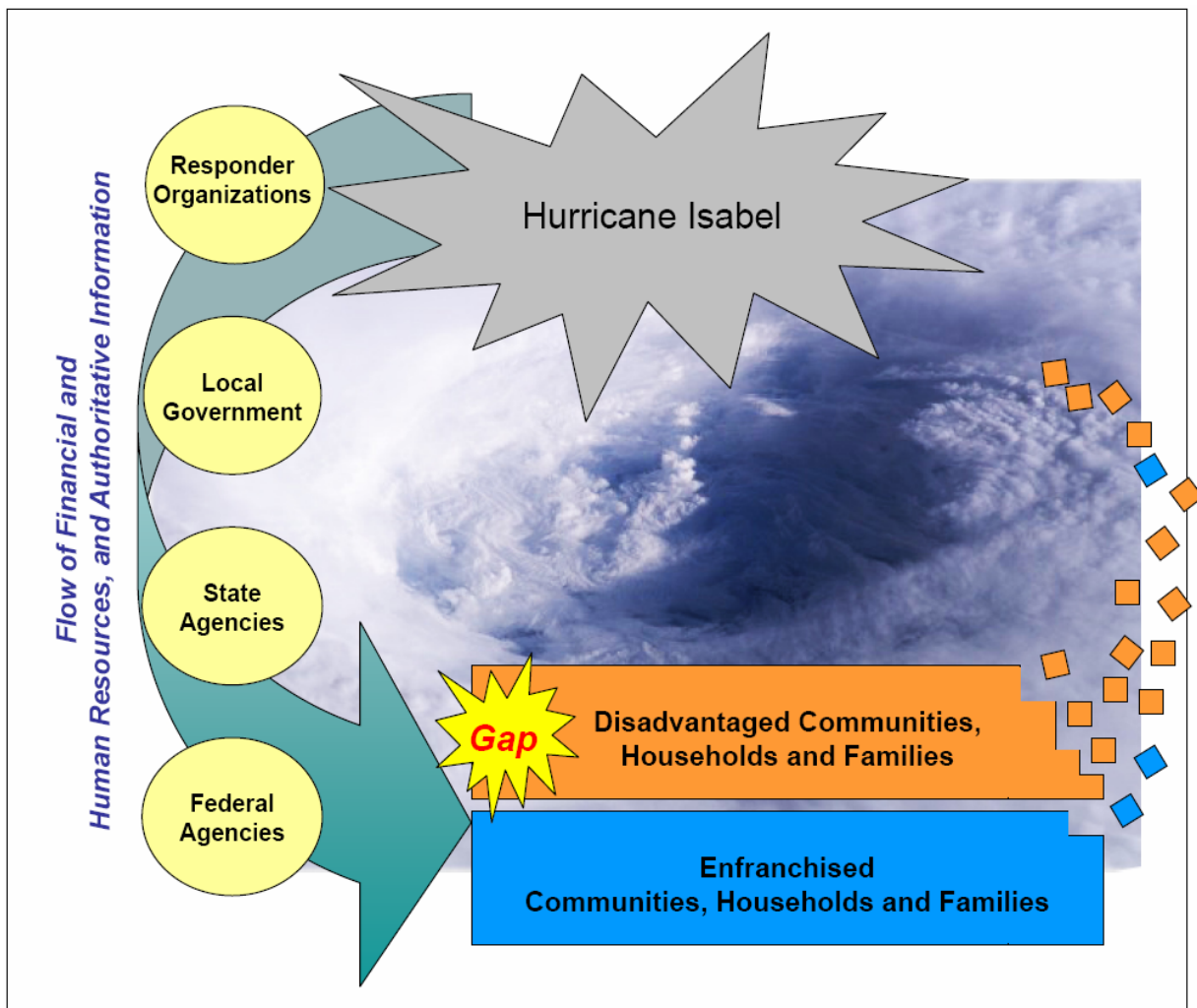
TABLE 1 STRENGTH OF FEELING

Rank	Title	Times Picked/Pts	Strength of Feeling
1.	Improved Understanding of Decision-making Factors	24/160	53.3%
2.	Estimate the Economic Impacts of Hurricane Forecasts and Potentially Improved Forecasts on a Variety of Spatial and Temporal Scales	19/155	51.7%
3.	Hurricane Forecasts and Warnings in the Information Age	20/141	47.0%
4.	Focused Research on Socially Vulnerable Populations	25/135	45.0%
5.	From Forecasts to Consequences: Develop a Coordinated and Synergistic Social Sciences Hurricane Research Agenda	19/120	40.0%
6.	Optimize the Understanding of Forecast and Warning Messages to Ensure Optimal Responses from the Message Recipients	19/108	36.0%
7.	Precision Versus Accuracy: Are Risks Adequately Expressed by Current Deterministic Forecasts?	17/104	34.7%
8.	Coordinated Research Designs and Methodological Improvements in Evacuation Behavior Research	16/98	32.7%
9.	Decision Making by Local Emergency Management Agencies	20/87	29.0%
10.	Evacuation Response Issues	18/82	27.3%
11.	Determine the Economic Cost of Evacuations ("Why you don't want to be on Bourbon Street next Tuesday.")	14/79	26.3%
12.	Determine the Most Appropriate Training, Tools, and Educational Materials (and the Most Efficient Delivery Systems) for At-risk Populations)	12/70	23.3%
13.	Mitigation Versus Evacuation: How to Reframe the Issues in Decision-Maker Parlance	12/70	23.3%
14.	How to Include Human and Social Costs in Cost-Benefit Analyses of Better Forecasts and Warnings	12/47	15.7%
15.	"I thought we lived in a democracy": Protective Action Decision Making by Businesses and Other Formal Organizations	10/45	15.0%
16.	How Does the Culture of the Organizations of Both the Sending and Receiving Ends of Forecasting Affect the Ability to Improve?	8/32	10.7%

Rank	Title	Times Picked/Pts	Strength of Feeling
17.	How Do Public and Private Sectors Respond to Potentially Conflicting Forecasts and Warnings?	8/30	10.0%
18.	NHRP–Pronounced “NaHurp”	7/27	9.0%
19.	Is Education the Best Mitigation?	7/20	6.7%
20.	Incorporate Fundamental Research into Studies of Perception of Forecasts, Individual Decision Making and Response, Communication, and Outreach, across Economic Classes and Cultures	6/18	6.0%
21.	Are We Looking for Our Keys under the Streetlight?	4/12	4.0%
22.	Is There a Changing Paradigm for Coastal Inhabitants?	3/10	3.3%

FIGURE 1**Meeting Needs of Disadvantaged Communities: Current Practice**

Socially and economically disadvantaged households and communities are disproportionately impacted by hurricane disasters such as Hurricane Isabel.



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In communities experiencing natural disasters, there can be disproportionately negative impacts on those segments that are socially and economically disadvantaged. For example, existing health disparities for many socially or economically disadvantaged residents can be dramatically compounded in the event of a natural disaster, particularly in communities with high levels of existing disease and disabilities and limited numbers of health facilities and practitioners. Factoring in the effects of largely uninsured populations and planning for emergency response in these specific communities is essential to prevent significant loss of life and long-term adverse social impacts (e.g., increases in violence, further economic displacement, substance abuse, breakdowns in civil order) in the event of a crisis. An empirical research summary and discussion of risk and status factors can be found at http://www.ncptsd.org/facts/disasters/fs_range.html.

In a 2003 discussion on emergency preparedness and response, experienced minority health professionals noted numerous issues surrounding emergency preparedness planning for communities that might be underserved. The issues included:

- Skepticism of information delivered by mainstream communication sources
- Issues surrounding cultural competency
- Disparities in Internet access and usage
- Significant representation of special needs populations in communities including children, the elderly, immunocompromised individuals, and the disenfranchised (e.g., immigrants, prisoners, homeless, and the mentally ill).
- Significant percentages of minority workers in service occupations
- Significant percentage of minority first responders
- Inadequate and poorly maintained infrastructure (rural and urban)
- Inadequate attention to Section 508 accessibility standards

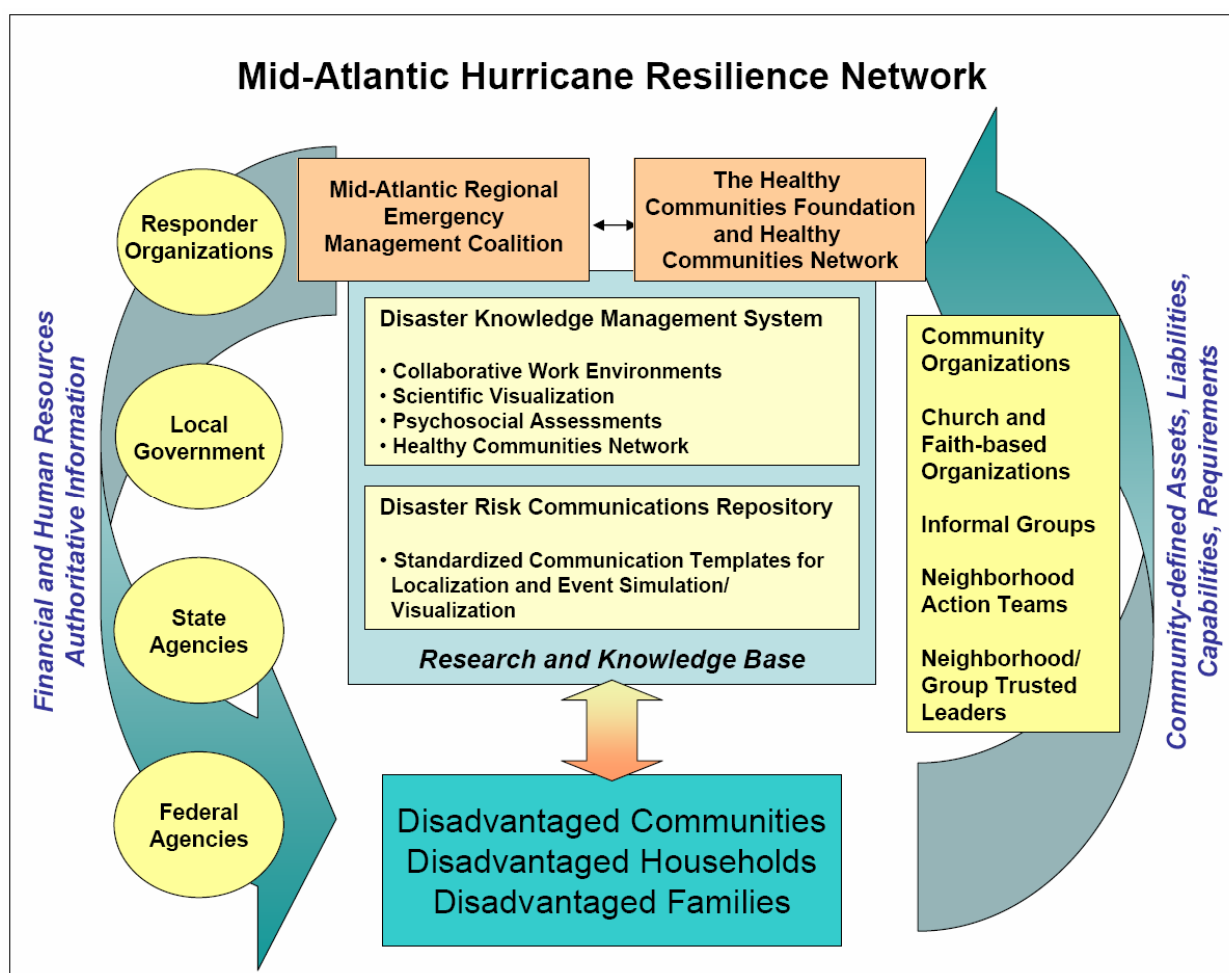
FIGURE 2

The Mid-Atlantic Hurricane Resilience Network

Approach to Addressing the Problem:

One of the goals of the Mid-Atlantic Hurricane Resilience Network is to build capacity in disadvantaged communities to enable citizens and local government officials to protect families, homes and workplaces from the impacts of hurricanes and other hazards. Figure 2 below shows key elements in the MAHRN approach to addressing the goal.

The MAHRN empowers disadvantaged communities to define their needs and communicate about disasters, hazards and risks, and enhances the efficacy of their general and specific preparedness, prevention, response and recovery actions.



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APPENDIX B

ACRONYMS

CDMHA	Center for Disaster Management and Humanitarian Aid
COMET	Cooperative Program for Operational Meteorology, Education and Training
EDA	Economic Development Administration
FEMA	Federal Emergency Management Agency
FIU	Florida International University
GIS	Geographic Information System
IHRC	International Hurricane Research Center (at Florida International University)
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NHRP	National Hurricane Response Program
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Association
NSF	National Science Foundation
NWRI	National Water Research Institute
NWS	National Weather Service (of the National Oceanic and Atmospheric Association)
OMB	Office of Management and Budget
SSHS	Saffir-Simpson Hurricane Scale
TAMU	Texas A&M University
TPC	Tropical Prediction Center
USAID	U.S. Agency for International Development
USGS	U.S. Geological Survey
WFO	Weather Forecast Office

APPENDIX C

BIOGRAPHICAL SKETCHES AND CONTACT LISTS

John L. (Jack) Beven, Ph.D.

Jack Beven has worked for the National Hurricane Center since 1988, where he now serves as Hurricane Specialist. It is his responsibility to issue track, intensity, and wind radii forecasts – as well as associated watches and warnings – on tropical cyclones in the Atlantic and eastern North Pacific. In addition, he is a workshop instructor for emergency managers and meteorologists and is lead author of the Tropical Prediction Center (TPC) column in *Mariners Weather Log*. Beven is also involved in various satellite data activities related to tropical cyclones, including the TPC focal point for implementing cyclone intensity estimates from the Advanced Microwave Sounder Unit. Beven received a B.S. in Physics from Louisiana State University and both an M.S. and Ph.D. in Meteorology from Florida State University.

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Susan Cutter is a Carolina Distinguished Professor of Geography at the University of South Carolina. She is also the Director of the Hazards Research Lab, a research and training center that integrates geographical information science with hazards analysis and management. Having worked in the risk and hazards fields for more than 25 years, Cutter's primary research interests are in the area of vulnerability science: what makes people and places vulnerable to extreme events and how this is measured and monitored. She has done extensive research on hazard preparedness, including hurricane evacuation behavior, and is the co-founding editor of the journal, *Environmental Hazards*. Cutter received a B.A. from California State University, Hayward and both an M.A. and Ph.D. in Geography from the University of Chicago.

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Nicole Dash joined the Department of Sociology at the University of North Texas in Fall 2002 after completing her doctorate on hazard-related decision making. As a Ph.D. student, she worked at the International Hurricane Center at Florida International University (FIU), where she received numerous grants to examine the impact of 1998's Hurricane Georges in the Florida Keys. Current research includes examining the long-term effects of 1992's Hurricane Andrew on Miami-Dade County and the potential methods for convincing owners of aged mobile homes to move into new, safer homes. Her main research interests include disasters, natural and technological hazards, and social vulnerability and inequality. Dash received a B.S. in Sociology from Florida State University and both an M.A. and Ph.D. in Comparative Sociology from FIU.

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Bob Dumont is a Senior Staff Meteorologist with the National Oceanic and Atmospheric Administration's (NOAA's) Office of the Federal Coordinator for Meteorology (OFCM), whose mission is to ensure the effective use of federal meteorological resources by leading the systematic coordination of operational weather requirements and services among the federal agencies. Among his responsibilities, Dumont serves as the Technical Director of the Interdepartmental Hurricane Conference, which provides a forum for Federal agencies and user-community representatives to review the nation's hurricane forecast and warning program and to make recommendations on how to improve the program in the future. Prior to joining OFCM, Dumont served as an Air Force meteorologist for over 25 years. He received a B.S. in Secondary Education, Mathematics, at West Virginia University and an M.S. in Atmospheric Science from Colorado State University

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Suzanne Frew is an independent consultant specializing in cross-cultural risk communications, strategic development, and disaster management/risk reduction in the United States and Asia. She also services as an instructor for FEMA, Asian Disaster Preparedness Center, OES, and Sonoma State University. During a 9-year tenure with FEMA, she worked mitigation education, marketing, and partnership development with disaster programs and recovery operations throughout mainland United States, the Caribbean, and Pacific Island Jurisdictions, primarily in areas of mitigation, public affairs, partnership development, and educational outreach. Frew received a B.A. in Public Relations/International Social Welfare from the University of Alabama, Tuscaloosa, and a MFA in Photography from Rochester Institute of Technology.

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John Gaynor is Program Officer of the United States Weather Research Program, which is a multi-agency cooperative program within NOAA that supports research directed towards accelerating improvements in forecasts of high-impact weather, such as hurricanes and other severe storms. He has been with NOAA for over 33 years, and his recent responsibilities include participating in strategic planning activities like a Natural Disaster Reduction Initiative dealing with hazardous weather and a Coastal Storms Initiative looking at improving coastal storm forecasts and understanding the impact of storms on the coast environment. Gaynor received both a B.S. and M.S. in Meteorology from the University of California, Los Angeles.

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Hugh Gladwin is the Director of the Institute for Public Opinion Research and Associate Professor of Sociology and Anthropology at FIU. His major area of research is the application of survey research and Geographic Information System (GIS) tools to understand large urban settings of high cultural and demographic diversity. Within that framework, his particular interest is to better model the interactions between the human population and natural systems, such as the South Florida ecosystem and extreme natural events like hurricanes. He is also co-editor (with Walter Gillis Peacock and Betty Hearn Morrow) and contributor to the book, *Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disaster*. Gladwin received a BA in Philosophy from Catholic University of America and a Ph.D. in Anthropology from Stanford University.

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Matthew Green began work as the FEMA's Hurricane Liaison Team Coordinator in 2004. His emergency management career started with the Florida Division of Emergency Management's Natural Hazards planning section in 1998, and he was later named Florida's State Meteorologist in 2002. He has been recognized for award-winning severe weather and hurricane preparedness campaigns by the Florida Tax Watch and both the Florida Governor's and National Hurricane Conferences. In 2001, Green worked closely with the National Hurricane Center in organizing a national Hurricane Awareness campaign and the issuance of a Presidential Proclamation, for which he received national recognition. Green received a B.S. in Meteorology from McGill University in Montreal and an M.S. in Meteorology from Florida State University.

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Eve Gruntfest has worked in the field of natural hazard mitigation for more than 25 years, specializing in the areas of warning system development and flash flooding. In 2003, she received funding from the National Science Foundation (NSF) for a 3-year project evaluating warnings for short-fuse weather events, particularly tornadoes and flash floods. She also recently edited the 2002 publication, *Coping with Flash Floods*. At the University of Colorado, Gruntfest teaches courses ranging from human geography, disasters and society, women in the world, and environmental planning. She received a B.A. in Geography from Clark University and both an M.A. and Ph.D. in Geography from the University of Colorado, Boulder.

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Sally Kane, an economist, joined the NSF in September 2002 after spending 7 years with NOAA. During her career, she has held positions in both research and public policy offices, including serving as Senior Economist for the President's Council of Economic Advisors. Kane is actively interested in climate research, including the topics of climate impacts, societal adaptation, decision making, role of information, risk, and public policy. Recent publications include topics such as mitigation/adaptation strategies for climate change and climate information as a risk management strategy. Kane received a B.S. in Ecosystems Studies from Dickinson College, an M.S. in Agricultural and Resource Economics from the University of Maryland, and a Ph.D. in Systems Analysis and Economics from the Johns Hopkins University.

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Since June 2004, Arlene Laing has been a Scientist for the Mesoscale and Microscale Meteorology Division of the National Center for Atmospheric Research (NCAR), where she is investigating the lifecycles of precipitating convection in Africa, the flood impacts of tropical cyclones, and the application of mesoscale modeling to volcanic tephra deposition. She is also a scientist with the Cooperative Program for Operational Meteorology Education and Training (COMET) at NCAR. Prior to joining NCAR, she spent 5 1/2 years in the Department of Geography at the University of South Florida as Assistant Professor and was a Visiting Scientist at NASA Goddard Space Flight Center, where she investigated hurricane rainfall using satellite data. Currently, she serves on the American Meteorological Society's Committee on Satellite Meteorology and Oceanography. Laing received a B.Sc. in Meteorology and Computer Science from the University of the West Indies and both an M.S. and Ph.D. in Meteorology from Pennsylvania State University.

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Since 1997, Stephen Leatherman has been the Director of the International Hurricane Research Center (IHRC) at FIU, as well as the Director for the Laboratory of Coastal Research, which is one of the four laboratories at IHRC. His major research focus is on storm impacts on coastal areas, including high-technology mapping with airborne lasers. Leatherman has authored or edited 15 books and authored more than 200 refereed journal articles and technical reports. He has also served on the National Academy of Science Post-Storm Disaster Field Team to survey hurricane damage, and has provided expert testimony on science policy issues regarding coastal storm impacts and Federal response. Leatherman received a B.S. in Geosciences from North Carolina State University and a Ph.D. in Environmental (Coastal) Sciences from the University of Virginia.

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David Letson specializes in the economics of weather and climate. As part of the Florida Alliance, he is using conjoint analysis to evaluate tradeoffs between the different dimensions of hurricane warnings (e.g., location versus intensity). At present, he is examining relationships between recreational angling and various indices of weather and climate for research sponsored by the National Oceanic and Atmospheric Association NOAA/National Marine Fisheries Service (NMFS). He is also a member of the Southeastern Climate Consortium to assess the value of seasonal climate information for agriculture in Argentina and the Southeastern United States. Letson received a B.S. in both Economics and English from James Madison University and a Ph.D. in Economics from the University of Texas at Austin.

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Michael McDonald has extensive experience in the public health area and, more recently, has turned his attention to developing communication strategies and programs that promote homeland security. At present, he is Coordinator of the National Disaster Risk Communication Initiative and President and CEO of Global Health Initiatives, Inc., a health information and technology company. He is also Communications Chairman of the National Capital Region-Emergency Response and Project Manager of the Healthy Communities Foundation Mid-Atlantic Hurricane Resilience Network. McDonald received a B.A. in an interdisciplinary study of medicine at the University of California, San Diego, and both an MPH in Planning Policy & Health Education and a Ph.D. in Public Health from the University of California, Berkeley.

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Betty Morrow is a sociologist with over 30 years of research and teaching experience, particularly in the areas of disaster sociology and gender and family studies. Her emphasis is on qualitative methodologies and program evaluation. From 2000 to 2003, she was Director of the Lab for Social and Behavioral Research with the International Hurricane Center at Florida International University (FIU), where she taught for 25 years. Recently, she coauthored (with Walter Gillis Peacock and Hugh Gladwin) *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disaster*. Morrow received a B.Sc. in Home Economics from Ohio State University, an M.A. in Sociology from Florida State University, and both an M.Ed. in Guidance and Counseling and a Ph.D. in Educational Research from the University of Miami.

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For 30 years, sociologist Jim Rivers has conducted research focused on behavioral health, with an emphasis on program evaluation. From 1999 to 2002, he directed an applied research center with projects that dealt with a wide range of urban issues, such as public health, safety, education, housing, and transportation. Later, as Director of the Laboratory for Social Science Research at the International Hurricane Research Center at FIU, he conducted research on hurricane-related topics (such as public policy and risk for mobile home park residents in urban Florida). Beginning January 2005, he accepted a Research Faculty position in FIU's Department of Sociology/Anthropology, where he plans to pursue a research agenda in collaboration with social scientists involved in hurricane-related research. Rivers received a B.A., M.A., and Ph.D. in Sociology from the University of Kentucky.

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Kevin Simmons joined Austin College as Associate Professor of Economics in 2003. Prior to that, he taught at Oklahoma City University for 4 years and worked as a Financial and Research Analyst at Texas Utilities Company for 16 years. Simmons' research in mitigation behavior has been widely cited and referenced in the emergency management and home safety community, as well as academia, and his articles have been published in a variety of academic journals, including engineering, law, business education, psychology, meteorology, and economics. His most recent articles involve the casualties associated with and protection from tornadoes. Simmons received a B.A. in Finance from the University of Texas at Arlington, an M.A. in Finance from Dallas Baptist University, and a Ph.D. in Economics from Texas Tech University.

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Dennis Wenger has been engaged in research on hazards and disasters for over 35 years, focusing on the social aspects of natural, technological, and human-induced disasters. Among his efforts, he undertook the only empirical study of the evacuation of the World Trade Center towers after the 1993 terrorist attack and served as the principal investigator for the first project to "Enable the Future Generation of Hazard Researchers." At present, in addition to currently serving as a Program Director at NSF, he is also the founding Director and Senior Scholar at the Hazard Reduction & Recovery Center at TAMU, as well as Professor of Urban and Regional Planning and Adjunct Professor of Sociology. Prior to joining TAMU, he was the Co-Director of the Disaster Research Center at the University of Delaware. Wenger received a B.A. in Music and an M.A. and Ph.D. in Sociology from Ohio State University.

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