Towards an Understanding of Hazardous Weather
A WAS*IS Perspective on First Responders

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1. INTRODUCTION

Recent weather events have highlighted the lack of communication and information between the science community and first responders – as portrayed in Figure 1. It became clear (especially from Katrina) that first responders and decision makers need independent, localized and timely data from which to make life saving decisions. Following from a series of Weather & Society * Integrated Studies (WAS*IS) workshops, surveys were conducted in the spring and fall of 2006 in two different geographical locations targeting responses to hazardous weather. The survey questions covered the perceptions, actions, and need in responding to weather related hazards by first responders.

Figure 1: The First Responder Community in this study is defined as organizations comprising of fire fighters, dispatchers, paramedics, and law enforcement.

WAS*IS in identifying its mission, aims to empower practitioners, researchers, and stakeholders in forging new co-operative relationships with responders to nationally occurring disasters (Figure 2). WAS*IS is an outreach group associated with the *National Center for Atmospheric Research* (NCAR) and *United States Weather Research Program* (USWRP). During the initial meeting (the first of a two-part workshop held in Boulder, Colorado in November 2005), a variety of projects were identified by participants who came from a broad spectrum of employers including: Federal Government, Local and State Agencies, Universities (Professors and Students), Research and Private organizations. One of the projects (the topic of this paper) focused on *First Responders* within three test bed communities - Austin, TX (*Joshua Jans & Dr. Cecil Keen, Minnesota State University*), Duluth, MN *(Amanda Brandt, NOAA/NWS*) and Washington D.C. (*Pamela Szatanek, NOAA/NWS/HPC*). This paper looks at a Texas situation and an event that subsequently occurred in Minnesota.

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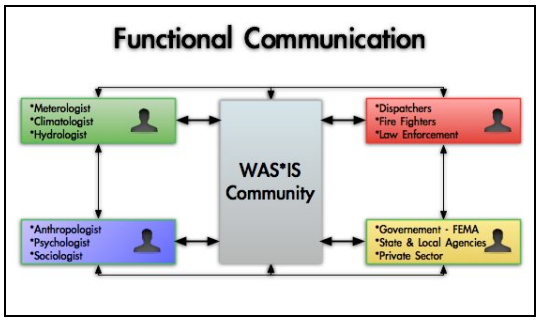

Figure 2: The Functional Communication role of WAS*IS.

2. CLARIFYING DATA COLLECTION

The ideas and discussions undertaken at the WAS*IS workshops brought into focus a recurring problem witnessed over several seasons of storm chasing experiences. One episode in particular, was a tornado outbreak that occurred in Harper County, Kansas on May 12, 2004. The chase team worked with the local Fire Department and Emergency Management crewmembers to assist with search and rescue efforts along with providing nowcasting guidance for the tornadic supercells that were developing and threatening the community. This real-life experience provided an insight into the lack of practical working knowledge that these first responders had of weather processes and technology, especially in the interpretation of weather information during a hazardous weather event.

Figure 3: A volunteer firefighter tries to direct rescue personnel during a tornado outbreak in Attica, KS using radar imagery **(L).** Emergency response personnel were unaware of the danger immediately behind them as a funnel cloud lowered to the ground **(R).**

2.1 Exploring Research Methods

After a review of available literature, informal discussions were conducted to understand the specific issues faced by first responders. The city of Austin, TX was chosen as an initial test bed. Having a personal connection with the Austin Fire Department (AFD) through a Fire Specialist and Trainer Randy Denzer, was one motivation. A second motivation was being able to capitalize on "*The Warning Project*", an unpublished research project by

Eve Gruntfest and Charles Benight, who undertook an extensive public survey in the greater Austin area.

The AFD operates on an $89.8 million annual budget, covering 43 stations, 223 operational vehicles (on land, air, and water), 1,032 uniformed personnel who cover a population just under 700,000 spread over 258 square miles. A survey was created with the aim of understanding the communication structure, the internal hierarchal procedures that exist, and the decision-making actions that occur when weather related disaster happens. The questionnaire also targeted individuals within the AFD on their perceptions, actions, and needs when responding to weather related disasters. From this information, it was hoped to obtain an understanding of the protocols by which actions are taken and if, what, and when appropriate training would be relevant.

2.2 Onsite Evaluation in Austin, TX

Two visits were made to Austin, TX in February and March of 2006. Several interviews were arranged with AFD management teams who administered the Fire Station Operations, Communications, Training, and HazMat. Onsite tours of the AFD facilities were also a benefit for a broader understanding of the first responder environment.

Figure 3: An onsite visit was made to tour the newly constructed Combined Transportation, Emergency and Communication Center (CTECC) **(L)** to interview Dispatchers about weather resources utilized on duty. **(R)**

During the course of one of the interviews, a meeting occurred with the Chief Battalion of the *Texas Task Force One Urban Search & Rescue Team* (TX-TF 1). TX-TF 1 is one of 28 National Urban Search and Rescue teams in the nation, which *FEMA* coordinates. It comprises of more than 300 emergency response personnel from 60 organizations across the state. TX TF-1 is a multi-disciplinary organization, which includes four areas of resource specialists including: Search Operations, Rescue Operations, Medical Treatment, and Technical Support and was responsible for assisting with more than 13,000 rescues in New Orleans during Katrina.

2.3 Austin Data Set

To increase the level and rate of response, the survey was placed online for participants to take at their own discretion. It was also promoted by five Chief Battalions (a senior rank within the AFD and TX-TF 1). A total of 92 surveys were completed. Fire Fighters and Dispatchers from the AFD accounted for 52% of the responses with the remaining 48% coming from TX-TF 1. Over 70% of the responders checked that weather plays a significant role in all of their actions and decisions made while on duty. The most important data sources utilized by both AFD and TX-TF 1 included: Internet (27%), local televisions stations (17%), NOAA Radio (16%) and 'Other ' – which included Pagers and Dispatchers (14%). While 49% believed that it was *their duty to simply get to the disaster after receiving an emergency call*, 74% reported they *would or sometimes would proactively position themselves in locations before disasters occur*. Surprisingly, when asked if it was their duty *to warn the public of impending disasters*, 48% responded *yes or sometimes*, while another 12% did so *only when requested by management*. Over 60% of the respondents agreed that their organization serves as a *post-disaster action group*. The overall confidence level of *interpreting weather data from their selected sources* was extremely high with 91% *strongly agreeing* or *agreeing* to this question. However, 92% also checked that *members of their organization needed to know more about weather, weather processes, and weather information to be better first responders*. Just over 80% of the respondents confirmed receiving forecast or warning information *forwarded directly to them by dispatch in advance of pending weather development*. The weather events that ranked the highest in terms of *greatest threat and impact* were: Flooding (19%), Thunderstorms (17%), and Hurricanes (15%). In dealing with the public, a 52% majority reported that they were *responsible or responsive, but act without a plan.* While another 37% checked that the public was *non-committal, irresponsible, and generally make poor decisions.*

2.4 Interpreting the Austin Data Set

What became evident from this survey, obtained during routine operations of these organizations (no Katrina events occurring), was the importance of weather and the need to interpret this accurately and in a timely fashion. Furthermore, both organizations have invested in stationary and mobile weather data solutions since Katrina. However, they have not yet been able to harness the full benefits of these resources in making better decisions during activation.

3.0 A Minnesota Tornado Event

A few months after the Austin TX survey was undertaken a real-life weather disaster (tornado) occurred in south-central Minnesota that gave another insight into first responders and their actions (Figure 4)

Figure 4: Researchers track the impact of the large tornado up close and personal on Hwy 99 on the outskirts of St. Peter, MN.

On August 24, 2006 a strong short wave trough consolidating with a surface low over central South Dakota, slowly tracked eastward along a strengthening warm - stationary frontal boundary across southern Minnesota. This soon gave rise a tornadic supercell, which resulted in a long-lived F-3 tornado (Figure 5 & 6).

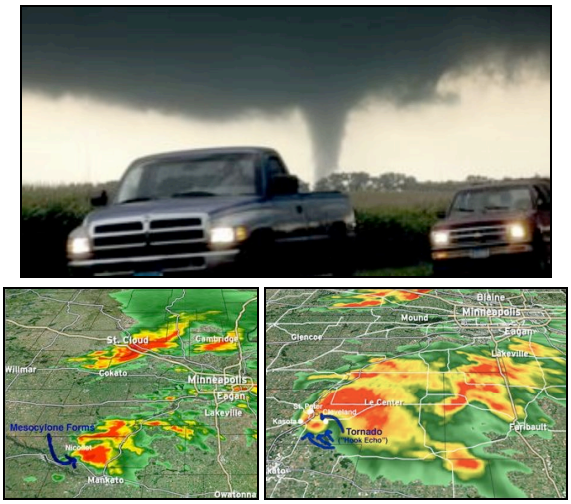

Figure 5: A tornado touches down south of Hwy 14 near Nicollet, MN 5:32 PM CDT. **(Top)** A meso cyclone is noted at 5:18 PM CDT near Nicollet, MN on radar. **(Bottom L)** and transforms into a well-defined hook echo near Kasosta, MN with magnified shot of the supercell at 5:52 PM CDT **(Bottom R)**.

The tornado touched down at 5:30 PM near Nicollet, MN and grew into a multiple vortex tornado with a damage path up to half-a-mile at times before it dissipated at 6:25 PM northwest of Waterville, MN (Figure 6). This 'local' event provided another opportunity to witness the unfolding of a weather event along with the reactions of responders and the public who were impacted. The mobile lab (Figure 5) provided an in-situ weather data collection and nowcasting tools. The entire event was documented from pre-storm conditions to disaster relief efforts in the days following with photographs (ground and aerial), interviews and questionnaires. The experience of combining storm chasing with the parallel responsibilities of warning the public (and officials) where possible, while evaluating and documenting the actions and reactions of first responders (and by-standers) was effectively living through a mission of WAS*IS!

Figure 5: Inside the mobile lab, researchers use the latest technologies for sophisticated mobile forecasting capability while monitoring the responses from the first responder community.

Figure 6: (**Top**) A red line represents the 33-mile damage path by a deadly F-3 tornado that tracked across Nicollet & Le Sueur County on August 24, 2006. **(Middle)** A large tornado tears through rural Cleveland, MN. **(Bottom)** An aerial photo representing one of many farmsteads that were completely destroyed in Le Sueur County by the tornado.

3.1 A Quick Response Survey

Within days of the event an online survey was available, which was followed up with phone calls, and mail-outs. The questionnaire aimed at identifying perceptions, actions, and reactions taken by first responders. A total of 42 surveys were received from 29 different organizations in south central Minnesota. Almost 60% of the returns were from Law Enforcement officials with Firefighters (31%) accountings for the next largest group. The remaining 9% came from emergency management personnel. Comparable to the Austin dataset, over 80% of the responders checked that *in their operations weather plays a significant role in all actions and decisions*. The most important data sources utilized by the first responder community in southern Minnesota included: Dispatch (54%), 'Other' – which included radio traffic with other first responders (14%), local televisions stations (11%) and Internet (9%). On a side note, it was learned that a combination of power-outages and failed back-up generators together with the tornado destroying

a cell-tower, led to communication failures. It was the dispatch and radio transmissions that had the largest impact during this event and these were effectively jammed or inoperable. The survey showed that 92% of the participants were aware of the possibility that severe weather was likely to occur on August 24th. The question - *when was your organization alerted for the tornado event on August 24th* provided some interesting insights.

Not alerted	3%
Less than 1 hour	44%
1 – 3 hours	40%
4 – 6 hours	4%
More than 6 hours	9%

For their actions prior to the event, 96% indicated they had *sufficient weather information* from the sources employed *to effectively respond during the tornado event*. In their dealings with the public, 52% of respondents reported that the public *act in a responsible or responsive manner, but act without a plan.* Another 37% chose the option that the public *are non-committal, irresponsible, and generally make poor decisions.*

It seemed, from the answers provided, that the respondents to the questionnaire were generally *well informed about weather*. Yet, 84% agreed that *a continuing education course focusing on weather for first responders* would be beneficial. In a follow-up question the most needed topics that were identified from a multi-choice list included Convective Weather, Media Weather Resources, Weather by phone, pager or cell phone, Winter Weather, and NOAA Weather Radio.

3.2 Interpreting the Austin and Minnesota Data Sets

While informative in many aspects, the questionnaires, not surprisingly, precipitated more questions than answers! Evaluating the behaviors of first responders seen during storm chasing experiences together with these more recent 'evaluative' ventures, suggest that there appears to be a disconnect between the actions observed and the answers provided in the questionnaires. In observing the actions in the field, it looked as if most first responders (predominantly firefighters in the case of Austin, and law enforcement officials in the case of MN.), that confusion and generally poor judgment prevailed in their understanding and reacting to 'weather'. Yet, in questionnaire format, the interpretation made would be one of order and understanding with sufficient information and adequate knowledge, from which to make informed decisions. While it is most likely that different persons were involved in those observed in the field to those who filled out the questionnaire (with perhaps supervisors and senior personnel receiving the questionnaire), one is still faced with a series of questions. Do first responders know sufficiently about weather processes and storm evolution to make sound decisions with? Do first responders have the relevant information from which to make informed decisions? Are first responders knowledgeable of the data sources available and are they able to interpret that data effectively?

4. CONCLUSIONS:

What both the Austin and Minnesota data relate about first responders is that they both acknowledge the importance of weather in their everyday operations. The recipients of our questionnaires acknowledge that they have adequate information from which to make informed and timely decisions, and that they are knowledgeable about weather. Yet the majority of all questionnaires returned indicated that they would benefit from additional training in weather. It appears, from subsequent personal communication in follow-up surveys, that the main source of their weather training is from storm spotter classes (e.g. Skywarn). While clearly valuable as an initial and perhaps observational training course, it goes little beyond that. What some supervisors and Chief Battalions were intrigued with (when informed about their existence) was what is now available in the form of digital data, mobile technologies, and ability to interpret such data in near real-time!

Our field observations, from several storm chasing excursions, confirm the fact that most responders are spatially adept at search and rescue operations during hazardous weather impacts, but appear 'blind' to the temporal developing processes that occur in severe weather situations. In the case of the Minnesota tornado, emergency vehicles were notably absent anywhere near the tornado-impacted areas. In fact, they were seen traveling in opposite directions away from the most significant part of the storm. When a new tornado warning was issued for Rice County, we witnessed two separate fire departments spotting on the west end of town rather than on the east end where rotation was clearly visible. One of the departments was quick to follow the research vehicle after seeing the equipment and our identification.

Overall, the mission of WAS*IS, is on target. It is understood more clearly than ever the needs to better enhance and align communication between the science of hazardous weather (with prediction and tracking-data resources) and the community of first responders with their decision makers. Storm spotter training is no longer sufficient, nor able to cover other relevant hazardous weather events (e.g. hurricanes), in an increasingly digital and technological era. Their capability of interpreting before, during, and in the field could be enhanced. By far the majority of those who answered our questionnaires acknowledged this and requested additional appropriate training.

5. ACKNOWLEDGMENTS

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