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Storm-based Warnings
Changes to NWS Warnings for the Digital Age

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1. INTRODUCTION

Since the inception of the modern severe weather warning program, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) has issued tornado, severe thunderstorm, and flash flood warnings for entire counties or parishes. For the past several years, these warnings have included numeric latitude and longitude points that outline a smaller area of greater meteorological threat. These sub-county 'storm-based' areas are increasingly used by graphical applications for television, the Internet, and even cell phones.

During 2005, 23 NWS Weather Forecast Offices (WFOs) participated in a test to expand the use of these smaller-than-county areas for convective warnings. These offices were asked to put less emphasis on county boundaries and greater emphasis on the storm location and movement. The test demonstrated several positive outcomes of storm-based warnings, including a dramatic reduction in the number of people required to take cover. It also allowed emergency management and other disaster response agencies served by these WFOs to focus their limited resources on smaller areas. In view of these benefits, NWS plans to move steadily towards the full implementation of storm-based warnings.

Several challenges to the implementation of storm-based warnings require feedback from the broadcast media. For instance, storm-based warnings have greatest value for those that have access to graphics such as television, internet, and cell phone technology. For visual text applications, such as "crawls" across a TV or computer screen, or for the radio listening audience, the benefit is limited by the ability to describe the storm location and movement in a text format.

The Federal Emergency Management Agency (FEMA) is currently rolling out the new Digital Emergency Activation Systems (DEAS). The authors will discuss outcomes of recent meetings on DEAS between NOAA's NWS, FEMA, cable television operators, cell phone companies and meteorological software vendors on the implementation of storm-based warnings.

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2. BENEFITS OF STORM-BASED WARNINGS

Currently, warnings are issued for entire counties or parishes even if only a small portion of the county is forecast to be impacted by the storm. This is especially problematic in the western U.S. where some counties are considerably larger than some states. The storm-based system will make possible the warning of small portions of individual counties or adjoining counties, only warning that portion of the population in the path of the storm.

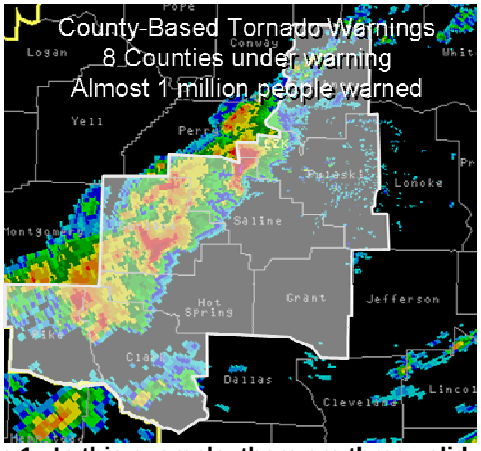

Figure 1. In this example, there are three valid tornado warnings that cover a total of eight counties (shaded area).

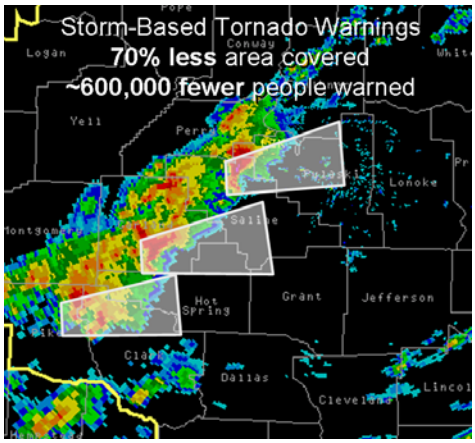

Figure 2. With storm-based warnings, the same three warnings as in Figure 1 cover 70% less area.

As cited earlier, a NWS demonstration test in 2005 showed reduction in the area warned at near 70%. A recent scientific study by University of Oklahoma Associate Professor of Economics Dan Sutter (now associated with University of Texas – Pan American) concluded that a reduction of 70% of the area warned would minimally save the economy *hundreds of millions* of dollars in reduced cost of sheltering (Sutter, 2006).

3. DISSEMINATION

Storm-based warnings are well placed to take advantage of modern dissemination technologies. New technologies, such as Geographic Information Systems (GIS), Digital Emergency Alert System (DEAS), Common Alerting Protocol (CAP), Valid Time Event Coding (VTEC), Extensible Markup Language (XML), Real Simple Syndication (RSS) and others can be leveraged to disseminate digital graphical data such as storm-based warnings directly to large portions of the population in real time.

Studies of public response to warnings show that the majority of the American public obtains weather information via television. For instance, 85 percent of the survivors of the April 8, 1998 tornado in Birmingham, Alabama reported becoming aware of the approaching tornado via television (Legates, 1999). While 70 percent reported receiving warning via television during the May 4, 2003 tornadoes in Kansas, Missouri, and Tennessee, with an even larger percentage (76 percent) reported hearing warning sirens (Paul, 2003).

In many communities the public also relies heavily on siren systems (Paul, 2003). Some cities have recently purchased siren systems capable of selectively alerting neighborhoods. Instead of sounding sirens for an entire metropolitan area, with storm-based warnings emergency managers could selectively sound sirens only for those in path of a dangerous storm.

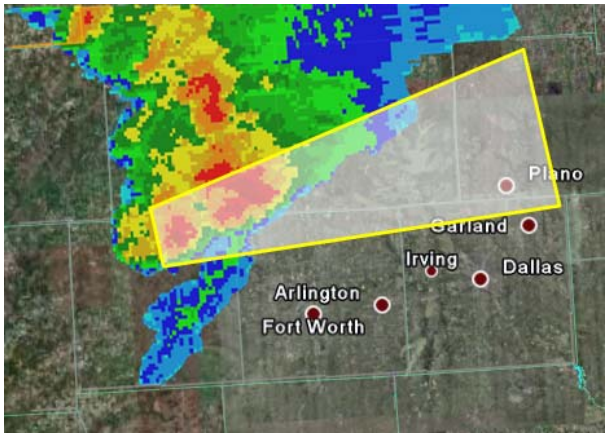

Figure 3: Most of the Dallas/Fort Worth metroplex is correctly omitted from this storm-based tornado warning. New siren system selectively activated.

Increased use of Geospatial Information Systems (GIS) allows storm-based warnings to be combined with a variety of other geospatial elements, such as radar imagery, topography, highways, county boundaries, etc. GIS also be used to verify storm-based warnings (Waters, 2007). An example of this usage is the current NWS display of weather radar data called RIDGE (Radar Integrated Display with Geospatial Elements) that has the ability to display storm-based warnings (currently the polygons of highest threat) as issued by NWS Forecast Offices (Stellman, 2005).

A combined use of GIS with existing internet technologies such as Extensible Markup Language (XML) and Real Simple Syndication (RSS) could be used to push storm-based warnings over the internet and directly to e-mail. These new technologies have the potential of directly reaching a much larger portion of the population. Although difficult to quantify, there is potentially a tremendous positive impact of increasing the direct dissemination of warnings to the public. An analysis of casualties from 1986 to 1999 revealed that tornadoes occurring during the night are much more dangerous than comparable tornadoes during the day. Fatalities were 66% lower, and injuries were 47% lower during the day than at night (Simmons and Sutter 2005). Alerting the sleeping population through direct dissemination of warnings would likely result in a significant reduction in loss of life.

Even with all of these emerging technologies and capabilities, the text portion of a weather warning is still vital. Radio stations and even NOAA's own Weather Radio are obviously limited to verbal descriptions and tracking of dangerous storms. Many television stations also simulcast audio over local radio stations during warning events, and a great number of TV stations utilize "crawls" of warning text over programming. The challenge is to find ways to use polygon warnings to improve on these types of service to the public.

Some changes have already occurred, with some warnings including directional delimiters (e.g., "A Tornado Warning is in effect for Southwestern "X" County). Also, format changes to include additional communities, landmarks, and even highway mile markers will be reviewed by partners in the media and private sector prior to planned testing during 2007.

To ensure that the format of storm-based warnings meet the needs of both the public and private sector, Texas A&M University hosted a collaborative technical workshop on December 5 and 6, 2006. The purpose of this workshop was to facilitate a discussion between the public sector (NWS, FEMA, and emergency managers) and private sector companies to set technical format requirements for these new storm-based warnings. Additional information on the outcome of this workshop is available by contacting the author.

4. FUTURE ACTIVITIES

During the upcoming year, considerable outreach activity within the NWS is planned prior to the implementation of storm-based warnings. This planned change will not work unless it works for private sector vendors of NWS warnings, emergency managers, and the media. Over the next few months several meetings and briefings are planned to gather input on important aspects the dissemination of storm-based warnings.

NWS forecasters have to be capable of producing quality storm-based warnings prior to implementation. This will involve gathering input from both the public and private sectors on important aspects of the concept of operations, such as best practices for polygon size and shape, updating warning information on intensity, location and movement of the storm within the polygon, and coordination aspects for storms moving from one NWS office area of responsibility to another. Software must also be developed to support operations. Most importantly, high quality forecaster training on both the new concept of operations and software enhancements is required.

Communication between all parties in the warning process is crucial. The authors encourage input from the public, private, and academic sectors. The e-mail address is included for the primary author.

6. REFERENCES

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