P2.3 THE GRAPHICAL SEVERE WEATHER WARNING INITIATIVE AT THE FORT WORTH NATIONAL WEATHER SERVICE OFFICE

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1. INTRODUCTION

The primary mission of the National Weather Service (NWS) is the protection of life and property through the issuance of warnings for hazardous weather. Warning messages have historically been text-based, and contain information on the warning type and area affected, location and nature of the threat, and a brief call-to-action statement for the population threatened by the hazard. Recent surveys of media and emergency managers, documented in the NWS Service Improvement Plan – 2004 (2004) strongly suggest that graphical warnings compatible with GIS software are needed, and, in fact, are part of the service improvement plan for public weather services. Further, a National Academy of Sciences workshop (2003) on communicating uncertainties in weather and climate information also encouraged the development of graphical warnings to convey threat information to the public.

In early 2003, the NWS Weather Forecast Office in Fort Worth, TX, (WFO FWD) began a collaborative project with the NWS Southern Region Headquarters (SRH) and the North Central Texas Council of Governments (NCTCOG) to develop a GIS-based graphical severe weather warning that also incorporates demographic information from the 2000 Census. The partnership is based on the belief that graphical warnings are clearly in the best interest of the local governments in North Central Texas. The NWS provides severe weather and flash flood warnings and radar reflectivity information, and NCTCOG provides detailed GIS data, information tools, and coordination in support of improved regional decision-making.

The primary motivation of the graphical warning initiative was to utilize the visual perspective to convey hazard information through integration of weather radar data, depiction of areas most at risk, population characteristics, and high detail geopolitical and terrain map backgrounds. Also, it was anticipated that graphical warnings would tap a growing local interest in integrating real-time meteorological data with local information systems in North Central Texas. The local information systems developed by local governments are used for many purposes, such as designing roads, planning infrastructure, managing floodplains, responding to emergencies, managing land for growth, and forecasting populations.

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2. GRAPHICAL WARNING GENERATION PROCESS

NWS forecasters issue severe weather and flash flood warnings using warning generation software to highlight an area on a radar reflectivity (or velocity) display. A box, or polygon, is graphically adjusted around the storm (or storms) of interest, and by interacting with a dialog box, details such as warning type, valid time, impact variables (hail size, wind speed, rainfall rates, etc) and safety information can be assigned to the warning. The software then generates the textual warning ready for dissemination. The text-based warning also contains a latitude/longitude listing of the vertices of the polygon developed by the meteorologist. It is this polygon, or “lat/lon string”, that is a key input into the graphical warning process.

The graphical warning process utilizes Geographic Information System (GIS) technology to integrate weather information with high resolution geographic data created and maintained by the local and regional governments of North Central Texas. The GIS capability enables several key events, namely the incorporation of WSR-88D radar reflectivity data and the warning polygon into the mapping process, the calculation of demographic information in the affected area, and the creation of a graphical depiction of the warning. The graphical warning is then available through the NWS FWD and NCTCOG Internet web pages. GIS functions of this type are conducted regularly by NCTCOG staff in analysis work, but automation was required to ensure that graphical warnings would be available at all times of the day. These additional functions were built in through a combination of programming, scheduling, and server event monitoring tools.

The WSR-88D base reflectivity binary files are provided by the NWS Southern Region Headquarters to NCTCOG upon completion of each radar scan. The binary files are very small in size, usually between 15-35 kilobytes, which makes them ideal for data transfer. Decoding tools written by NCTCOG take the binary data and convert them to GIS format. The product is loaded into ESRI ArcSDE, which is a database driver for the storage of GIS data in database format. The combination of GIS-based radar data, and the use of database relational features, produces very quick and efficient updates of live radar data on the web. Other data, such as velocity and precipitation accumulation, have been added to this procedure and will be available in upcoming phases of the project.

Severe weather and flash flood warnings are provided to NCTCOG in real time by the NWS Southern Region Headquarters. Warnings arrive in the form of an ASCII text document. The various components of the warning are broken down and re-formatted into an XML (Extensible markup language) document, which is loaded into a server database. They key for GIS-related functionality is the presence of the latitude/longitude pairs for each vertex in the warning polygon. This is decoded and re-expressed as a polygon object in the GIS. The availability of this polygon as a legitimate shape allows nearly all GIS feature layers (e.g., demographics, traffic, topography, live radar data, land use, critical facilities) to be available for query and analysis. It also allows for the warning polygon to be mapped in conjunction with these layers and produced back out as a graphic.

A final step in the graphical warning process is to make the data available for use by emergency managers and public. GIS mapping images generated at NCTCOG are uploaded back to the NWS Southern Region Headquarters and immediately made available on the NWS FWD web page. A web page that describes the warning and demographic data in the warning polygon is also generated and uploaded to the NWS. This allows the larger capacity of the Southern Region Servers to handle the Internet traffic generated during storm events. The graphical warnings are also available on the NCTCOG web site.

The current phase of the graphical warning initiative has focused on the generation of the mapping graphic, and the spatial query of demographic data beneath it. This shows the area of impact and provides a general profile of the people living in that warning area. The demographic data that is used for the warning polygon analysis is the same data that is used to feed transportation models in North Central Texas, determine school enrollment, and assist economic development studies. Applying it to storm impact analysis is not only appropriate, but is consistent with goals of multi-objective benefits. The high detail required to estimate where people live and work as a source of traffic is also useful in defining where people live and work in the path of storms.

3. GRAPHICAL WARNING EXAMPLE

Figure 1 shows an example of a Tornado Warning for Palo Pinto and Parker Counties, TX, in April 2003. The warning polygon clearly outlines the area affected by the storm in relation to the radar reflectivity image and a high detail terrain map. To the right of the image are various aspects of the warning, including warning type, size of the affected area, storm movement information, and demographic information within the threatened area.

The demographic fields within the warning area include population size, percentage of that population living in single family homes, multi-family dwellings, and manufactured homes, percentage speaking English (based on individual responses to the 2000 Census), urban versus rural locations, and a percentage of the population not living in Texas in 1995. The latter variable is thought to be a possible measure of people who may be relatively new to North Texas and not have much experience with severe weather.

Presently, the graphical warning is available on the WFO FWD web page approximately two minutes after issuance of the text-based warning.

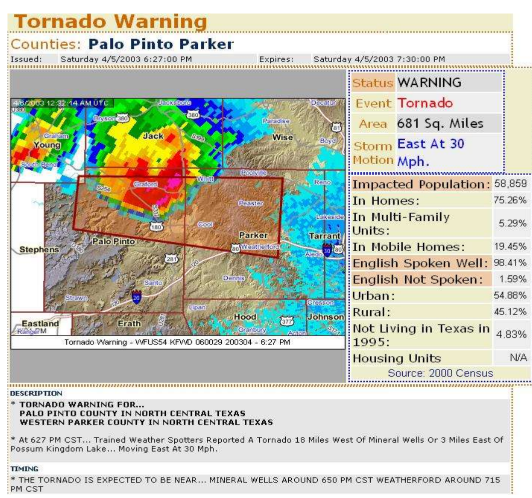

Figure 1. Graphical Severe Weather Warning

Real-time severe weather and flash flood warnings can be accessed through the WFO FWD

web page at:
http://www.srh.noaa.gov/fwd/gwarn/nwswarning.html

4. FEEDBACK AND FUTURE OBJECTIVES

Feedback thus far (after three months of warnings available on the WFO FWD web page) has been uniformly very positive. Emergency officials commented that they benefit from seeing critical information (storm location, warned area, and map data) in one graphic, allowing for planning of potential impacts and response. Local media interest began soon after the warnings were available on line, and focused on the collaborative aspects of the project as well as the ability to see the warning as an image rather than text only. More detailed feedback will be presented at the conference poster session.

Future objectives include adding capabilities to enhance the utility of the Internet-based graphical warnings, and making the demographic information available to NWS warning decision makers prior to warning issuance. The latter step allows for the warning call-to-action information to be tailored to the affected population. There are plans to add animation to the warnings to view movement and development of storms in and near the warned area. Other planned improvements include options to change map backgrounds, display additional demographic fields, and allow for zooming for more detail. Also, an additional objective is to develop the capability for local emergency officials to display local information layers to the GIS-based map, such as the location of critical care facilities, locations where hazardous materials are stored, etc.

From a performance perspective, access to the graphical and demographic information allows for the computation of statistics on the size of the area placed under warning and total potential population affected. Such information could play a role in assessing the value of a warning service.

5. REFERENCES

National Academy of Sciences, 2003: Communicating Uncertainties in Weather and Climate Information, pp. 39-40. Available from the National Academies Press at http://books.nap.edu/catalog/10597.html.

National Weather Service, 2004: NWS Service Improvement Plan – 2004. pp 6 and 43.