J9.1 An Overview of GIS Projects and Applications at Southern Region River Forecast Centers.

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1. INTRODUCTION

Technological advancement over the past few decades affords us the ability to work with increasingly higher resolution data and information. Geographic Information Systems (GIS) use is expanding at a rapid pace and several independent companies have developed software to disseminate the various datum.

GIS software have been distributed and utilized at many of the National Weather Service offices across the Southern Region including the: Lower Mississippi (LMRFC), Arkansas-Red (ABRFC), West Gulf (WGRFC), and Southeast River Forecast Centers (SERFC). These offices have produced better quality graphics and datasets as a result of the efforts of the forecasters and developers in each office. In the late 1990's and in early 2000, each office independently worked with GIS developing programs to tackle specific needs. However, after demonstrating the capabilities of GIS at a NWS technology transfer meeting, many offices teamed their GIS efforts to produce seamless data and web products that are more effectively utilized by the end users.

Recently, after solidifying a team approach and now that other neighboring river forecast centers and weather service offices have acquired and learned about GIS software, the NWS Weather Forecast Offices and River Forecast Centers are working together to continue combining individual data sets into regional views and data sets. These efforts include the data collection, geoprocessing, display and dissemination of the data using images as well as an internet map server. This paper will review the current and future GIS efforts within the Southern Region National Weather Service

2. PRODUCTS, DATA, AND METHODOLOGY

2.1 Radar/Warnings

The experimental graphical severe weather warnings depicted in Fig 1 represent a collaborative effort between the National Weather Service Dallas/Fort Worth, the NWS Southern Region Headquarters, and the North Central Texas Council of Governments (NCTCOG). The NCTCOG is a voluntary association of, by and for local governments, established to assist local governments in planning for common needs, cooperating for mutual benefit, and coordinating for sound regional development. The experimental graphical warnings are generated whenever a Severe Thunderstorm, Tornado, or Flash Flood Warning is issued by the Dallas/Fort Worth NWS office. The graphical severe weather warning depicts current radar reflectivity data from the Fort Worth WSR-88D Doppler Weather Radar, the area warned by the warning forecaster during the warning preparation phase (**warning polygon)**, and also the demographics of the area affected. The warning polygon is delimited by a lat/lon string at the bottom of every NWS short-fuse severe weather warning.

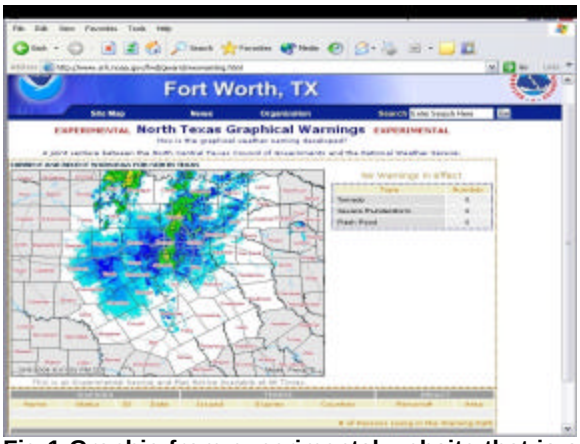

Fig 1 Graphic from experimental website that is a partnership between the NWS and NCTCOG.

Using the "warning polygon" area, a demographic database at the North Central Texas Council of Governments is queried to determine characteristics of the population at risk. These characteristics include total population, population by sex and age within each city or town in the path, the percentage living in single family homes, multi-family dwellings, and manufactured homes. Additionally, the percentage of the population that, by their own responses to the 2000 Census, do or do not speak English is determined, and the percentage living in

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urban and rural locations. Finally, the percentage of the population in the path of the storm that (again, based on 2000 Census responses) did not live in Texas in 1995 is determined. This is thought to provide some measure of the relative number of people who are new to the area and may not be familiar with Texas weather.

The graphical warnings merge Geographic Information System (GIS) technology and the NWS warning process. The result is weather data from the NWS integrated with high resolution geographic data created and maintained by local and regional governments in North Central Texas. (Bunting, et. al) This website can be reached through the NCTCOG at http://www.nctcog.org/weather/graphicalwarnings/nwspublic.asp or at the Dallas/Fort Worth NWS website: http://www.srh.noaa.gov/fwd

2.2 Climate Data

Through a recent collaborative effort between the Southeast RFC, Arkansas-Red RFC, West Gulf RFC, and the Lower Mississippi RFC, multisensor precipitation estimates (MPE) created at each RFC have been combined into a singe suite of products for all of Southern Region, accessible from a single website. In the past, to view rainfall estimates over an area, one would have to jump from website to website to find this information. Now thanks to this effort, users only need to go to this website/link http://www.srh.noaa.gov/rfcshare/p_SR.php

This site provides a single point of access to the data and its derivatives. The derived products produced include percent of normal rainfall and departure from normal for various durations including past 24 hours, 7 and 14 days, current month and current year. The program currently runs at the West Gulf River Forecast Center and combines the data from all 4 Southern Region River Forecast Centers. A region wide climate product utilizing the PRISM datasets as a 30 year average is the source of climatic normals. Numerous images are created which can be accessed by clicking on a state or River Forecast Center (RFC). On the site, the user has the ability to zoom in on the graphic as well as an option to download the grids as point shapefiles for desktop GIS processing. An example of the Southern Region Mosaic is shown in figure 2. This product continues to be used in the Climate Prediction Center's Drought Monitor product.

An example depicting departure from normal is shown in Figure 3. To demonstrate the relative accuracy of the data and the graphic, as of Oct 25, 2004, Baton Rouge, LA had received 60.94 inches of precipitation. Normal rainfall to this date is 52.17 inches which equates to 117% normal. The graphic depicts this region to be in the 110% - 140% range. This is just one example. However, results may vary depending on radar coverage, beam height, rain gauge coverage, and the inherent errors associated with MPE data. Studies are underway to determine the characteristic error associated with MPE data. Nonetheless, a user can get a relative sense of how wet or how dry an area is from assessing the graphic.

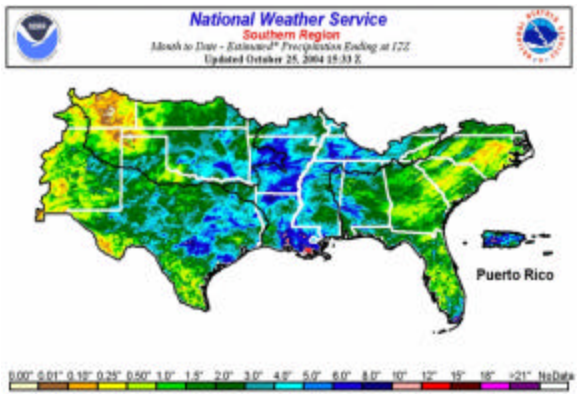

Fig 2. Mosaic of Multisensor Precipitation Estimates (MPE) from the River Forecast Centers across Southern Region.

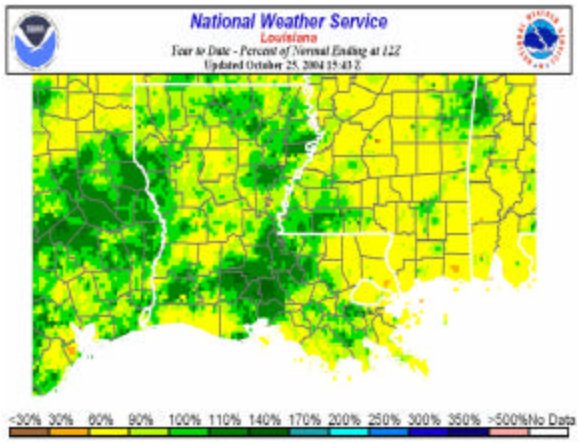

Fig 3. A zoom of Louisiana showing percent of normal (30 yr avg) rainfall for the year to date time frame.

2.3 Interactive Products

The examples discussed in sections 2.1 and 2.2 demonstrate the ability to use GIS and create a product from raw data that can be turned into an informative product and shared with the public. This next section will describe some of the GIS work to help forecasters internally.

2.3a Interactive Image Generator

One of the latest applications is a Visual Basic (VB) executable using ArcObjects that can be used to create a user specified drill-down image of any ArcGIS 8.x project file. This was created so that a person with no GIS experience can create images of any map for briefings etc. The program reads a configuration file containing directory/file information,

ftp protocols, and the drill-down specifications. A user can also specify the layer to query (State, River Basin, county, etc.) and a feature within that layer to select or the user can specify the bounding latitude-longitude coordinates. Once set, the executable can be run manually or off the scheduled tasks on any Windows machine with ArcGIS 8.x installed. This was recently set up at the LMRFC and SERFC for the Hurricane Liaison Team briefings to FEMA.

2.3b Dambreak

The LMRFC is using ArcGIS 8.x with a public domain extension to set up NWS Simplified Dambreak (SMPDK) scenarios. This is accomplished by downloading United States Geological Survey (USGS) 30m Digital Elevation Models (DEM's) and USGS 7.5 minute DRG's (scanned toposheet TIFF images) and loaded into ArcGIS for reference. Then, a public domain profile extractor is used to pull cross sections from the maps to run, with some formatting, in the NWS SMPDK model.

2.3c Flood Outlook Product

This product, called Flood Outlook Potential(FOP), uses collaboration between RFC's and forecasters to produce a 1-5 day flood outlook. Avenue code, which is an object oriented language that is specific to the ESRI Arcview 3.x software, was the backbone to the original FOP. The older avenue code has been converted to Visual Basic using ArcGIS 8.2. With this program, forecasters can subjectively draw polygons over areas where

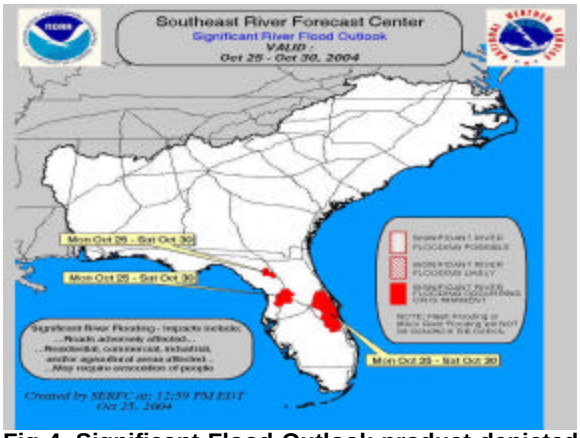

Fig 4. Significant Flood Outlook product depicted significant flooding potential which is produced by individual RFC's and be combined into a national mosaic of all 13 RFC's.

moderate or greater flooding is possible, likely or imminent over the next 5 days. The program, re-coded at the LMRFC, SERFC, Missouri Basin RFC(MARFC) and the North Central RFC(NCRFC), exports polygon coordinates created by a forecaster to a file that is transmitted to the Hydrometeorological Prediction Center (HPC). At HPC, the 13 RFC files are combined to create a national product. The local product is shown in Figure 4. The new version of the program also allows the forecaster to overlay 5 day forecast rainfall. An upcoming release of the program will feature yesterday's flood outlook polygon, and any neighbor's polygons.

2.3d River Status Maps

One week before a hurricane or tropical storm makes landfall in the U.S., meteorologists and hydrometeorologists from the NWS weather forecast offices and river forecast centers are deployed to the National Hurricane Center to aid the NHC in support of FEMA. The team, called The Hurricane Liaison Team, provides both hydrological and meteorological information to decision makers using a multitude of briefing capabilities. However, while each RFC page individually contains very valuable information, there isn't any one site that combines the best of the RFC websites to give an overview of current and forecast flooding from tropical systems as they move inland. Scripts were developed to access the RFC Informix database and generate flood status information tables. A VB executable accesses these tables and generates a large scale graphic using ArcGis 8.2. The maps are then used to brief State and National level government. This has proved to be very valuable because of its consistency across boundaries (figure 5).

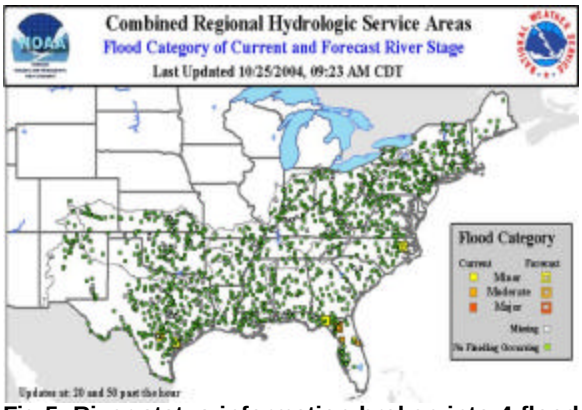

Fig 5. River status information broken into 4 flood categories. The map is clickable and gives current status as well as forecast information.

3. FUTURE PRODUCTS/ENHANCEMENTS

3.1 Internet Map Servers

With future enhancements/upgrades of the GIS software from ESRI combined with a National Weather Service move to support the software, the future products and capabilities within the operational and research community will vastly improve. Of particular interest to the National Weather Service as well as Emergency Management and other public officials is the deployment of internet map services capabilities. Map servers provide the foundation for

distributing high-end geographic information systems (GIS) and mapping services via the Internet. The software enables users to integrate local data sources with Internet data sources for display, query, and analysis in an easy-to-use Web browser. Efforts at the national and regional levels are ongoing to implement this software which will serve up the same data used to create the current images on the web.

Recently, the NWS developed an ArcIMS server using GIS for planning and briefing by both internal and external users. Two applications were developed from the use of the server. The first application presents river flood information that is gathered using the same process described earlier in the status map generation. The second application presents tropical information i.e. tracks, both forecast and past, radar, cyclone related satellite, quantitative precipitation forecast (QPF), and several other variables. Graffman, 2004

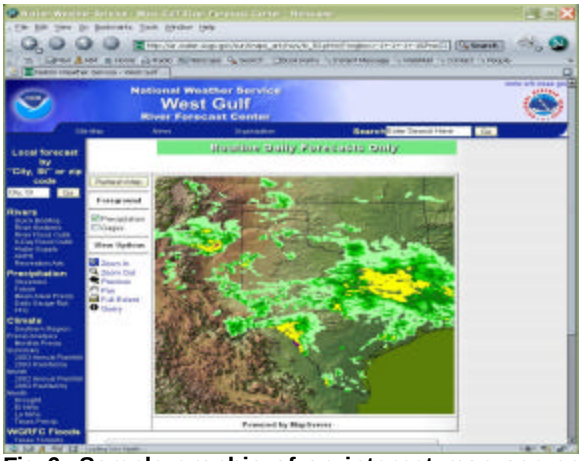

Fig 6. Sample graphic of an internet map server depicting 24 hour precipitation. Map servers provide the ability to share, zoom, and query data.

3.2 Verification

As the NWS moves more into the digital services operations at increasingly higher resolutions, there is a need to verify the forecasts that are issued. By utilizing high resolution rainfall data sets generated by the RFC's, satellite information and GIS, we can begin to give NWS forecasters an idea of how forecasts verify at more than just a single observation point. GIS may also play a role in verifying high resolution datasets that lack a high density observation network such as temperature, dewpoint, and wind through interpolation methods combined with topography. All of these techniques are now being considered and explored.

4. CONCLUSIONS

The addition of the Arcview/GIS software has enabled the NWS to produce high quality graphics to complement and/or replace traditional text products. Using Avenue, Visual Basic, Java, Python, and many other programming languages compatible with GIS software, custom tools, interfaces, and complete applications can be easily developed to suit the product or products it is designed for.

The software has also aided in ideas and design due to the fact that it is made available to anyone. Many websites contain projects and scripts already designed for specific tasks which can be included into projects being designed locally or nationally. The program language is directly transferable from one project to another.

One very important feature of the software is its ability to run automatically when triggered by time or an event. This technique allows the production of grids, images, and various other datasets automatically. Forecasters can then save time and effort in the creation of the products while still creating high quality graphics and datasets for users.

Many projects are still under way and as the software expands in capability so will the products produced. Only recently have we entered into the realm of a national interactive program for creating products utilizing the software's capabilities and certainly it will not be the last.

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