7A.4 DEVELOPING GEOSPATIAL DECISION SUPPORT TOOLS FOR A LOCAL NWS OFFICE AND OTHER REGIONAL DECISION MAKERS

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ABSTRACT

In recent years, the National Weather Service (NWS) and other regional Decision Makers (i.e. Emergency Managers, Community Planners, Media, General Public) whom have not traditionally utilized GIS have begun to fully integrate this and other Geospatial technologies into their daily operations. This is due, in part at least, to the evolution of these technologies, which have become much more user-friendly, web-based, fully customizable, more affordable, and in some cases, free to integrate. This presentation will focus on four specific GIS and Geospatial decision support tools developed for a local NWS Weather Forecast Office (WFO), which as a result also benefited many other Decision Makers in the region. The work was completed by a multi-agency collaboration directed by the UNC Asheville Renaissance Computing Institute (RENCI) Engagement Center, with support from NCDC and the Greenville-Spartanburg NWS WFO located in Greer, SC.

The decision support tools included standard GIS applications (i.e. ArcIMS, ArcGIS Server), as well as customized Google MashUp and Open Source applications. The GIS applications provided critical, yet standard GIS information such as infrastructure, cadastral, emergency management, and physical terrain datasets, data that are not necessarily easily obtainable by the NWS. An entire ArcSDE database was developed for use with these applications as well as for in-house use with AWIPS and other programs. The MashUps and Open Source applications were an effort to provide easy and spatially based access to such information as live weather and transportation webcams, weather stations (regardless of type in which real-time readings are observed), and historical precipitation and stream flow data. Techniques, examples, and lessons learned will be presented.

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1. INTRODUCTION

GIS and Geospatial technologies have the potential to provide critical ancillary information pertaining to weather, climate, and hazard situations in a variety of formats to local and regional decision making groups such as county emergency mangers, first responders, meteorologists, community planners, the media, and even the general public. While much data now exists, accessing this data in an efficient and timely manner can be problematic if the appropriate decision support tools are not available. Decision makers such as the ones mentioned above rely on a variety of models and information sources to perform their respective responsibilities. By combining environmental, meteorological and societal datasets and information into integrated GIS and Geospatial decision support tools, local and regional decision makers can potentially make more informed decisions and forecasts (Graffman and Kozimor 2005; Haberman et al. 2004).

2. GIS TECHNOLOGY FOR THE LOCAL NWS

It has only been in recent years that the NWS has begun to fully integrate GIS technologies into their daily operations. While GIS is certainly not a platform meant to replace AWIPS or other meteorological software, it can serve as a supplement to forecast operations. By combining GIS data with forecast models, a better understanding of the physical and humanistic spatial complexities and the potential societal effects of weather, especially inclement or severe weather, can be better understood, leading to potentially better decision making.

GIS datasets pertaining to property ownership, population demographics, locations of critical or at-risk infrastructure, and transportation networks can assist meteorologists in making better informed decisions. For instance, if a tornado warning is to be issued, being able to plot the projected path or warning polygon over population data could assist in notifying potential victims, such as a school, hospital, or shopping center.

GIS data typically contain multiple attributes, often including telephone numbers or other contact information. The plotting of the data could be completed in either standard GIS software, or better yet, AWIPS, which does read GIS shapefiles (Waters et al. 2005). Other examples include understanding what the potential total affected population may be due to the issuance of a winter storm watch or warning.

Other potential uses of GIS technology at the local NWS office include severe weather verification, especially tornadic events (Rawles et al. 2006; Waters 2006). Severe weather verification can occupy much time when having to be done in the field. GIS data and software can provide a more automated approach to some of the verification tasks (Camp 2008). However, having quick and easy access to a variety of GIS datasets is critical.

The local Greenville-Spartanburg NWS WFO in Greer, SC had a need to access and reference basic GIS data. GIS datasets such as cadastral, transportation, infrastructure, civic, physical, and population are fairly common and basic GIS data layers in the GIS world. However, datasets such as these are not necessarily easily accessible in a NWS WFO. This is due in part to the lack of appropriate software, expertise, and the time required to obtain, archive, and maintain such data. In addition, many NWS County Warning Areas (CWA) cross multiple state boundaries. This, combined with collecting local scale data from multiple counties, makes the data collection process for a NWS office difficult at best. Data has to be collected from multiple organizations and then correctly merged together to form seamless datasets for the NWS CWA.

2.1 *Developing Standard GIS Viewers*

Through a unique collaboration involving the UNC Asheville RENCI Engagement Center and the GSP NWS WFO, data for the entire GSP NWS CWA was collected, processed, and entered into an ArcSDE database. ArcSDE technology, created and provided by the Environmental Systems Research Institute (ESRI), is a standard industry software platform for GIS databases, and works well with server based products. After the data collection process, a GIS Viewer was built utilizing the ArcIMS platform. ArcIMS was ESRI's initial attempt at serving GIS data across the web via interactive GIS-based maps. The initial product allowed forecasters to access basic GIS information at any computer terminal in the NWS office that was connected to the internet (Graffman and Kozimor 2005; Stellman and Welch 2003).

However, ArcIMS proved to be an unstable platform and difficult to customize in order to meet the decision makers' needs. As a result, ESRI's latest server technology was implemented to provide a better and more reliable solution for the GSP NWS WFO (Figure 1). ArcGIS Server allows for a fully customized interface that can even be integrated with other Open Source technologies through its JavaScript API. The original ArcIMS viewer was migrated to ArcGIS Server to serve as the GIS Viewer for the GSP NWS CWA.

3. GEOSPATIAL MASHUPS

Another increasingly popular Geospatial technology application is a MashUp. A MashUp can be defined as any web application that combines data from more than one source into a single integrated web-based tool. MashUps are especially effective at providing a spatial context to non-spatial data. They are also advantageous in that they do not require the data user to necessarily store data locally, which can be especially difficult for large amounts of imagery or elevation datasets. MashUps often combine popular programs such as Google Earth, Microsoft Virtual Earth, WorldWind, or other Virtual Globe programs that allow for 3D visualization and analysis, all which can serve as supplemental platforms for weather applications (Smith and Lakshmanan 2006). Other advantages to a MashUp are that it is fully customizable, the code is relatively simple, it generally uses Open Source software, which means it is free, and it is typically easy for the decision maker or user to understand and operate.

3.1 *Webcam Viewer*

Webcams (cameras connected to the Internet that depict snapshots or real-time images of the environment) can provide critical "verifications" as to whether or not inclement weather is occurring, such as snow accumulating on roads, rivers flooding, or foggy conditions, all which can greatly assist emergency managers, meteorologists, school districts, and other decision making groups. Webcams are hosted on many websites by a range of different sources, including private weather enthusiasts, ski resorts, the U.S. Forest Service, the state Department of Transportation, development and real-estate companies, and other state and federal agencies. However, webcams on these sites generally do not provide any spatial context or other important webcam attributes. In addition, navigating to more than 50 different websites to view all of the available webcams in the region can be problematic when trying to quickly access current weather conditions.

A MashUp to create an interactive, online, "Webcam Viewer" was created combining a Google Application Program Interface (API), Google Maps, and a database of the currently available webcams in the greater Southern Appalachian Region, which includes most of the GSP NWS CWA (Figure 2). The application currently includes over 100 webcams. Google Maps provides the spatial context in the form of a map background. The user can toggle between a variety of map backgrounds, including satellite, terrain, USGS topography, aerial imagery, or a basic road map. In a beta viewer that is linked from the Webcam Viewer, there is also an option to toggle into Google Earth mode in the browser, without having to launch the separate Google Earth program. Additional layers can be served through KML files, such as county or watershed boundaries. Not only does the MashUp provide spatial information, but other important attributes such as camera source, location, elevation, direction the camera is pointed, type of view, and refresh rate of each webcam (Figure 3). Once a webcam is selected in the Viewer, the attribute table appears along with a current image of the webcam on the right side of the map. The user can obtain a larger webcam image by either clicking on the smaller webcam image or the source link in the attribute table.

3.2 *Weather Station Viewer*

Local decision makers expressed interest in having access not only to official weather stations, but un-official weather stations as well. These included private weather enthusiasts, local TV station networks, and schools. While data collected at these sites are not necessarily quality controlled, they may help fill in spatial gaps of weather stations and at least provide a reference, especially during times of inclement or severe weather, a time when many weather stations may become inoperable.

This led to another MashUp that was created to provide access to all weather and climate stations in Western North Carolina, including a large portion of the GSP NWS CWA (Figure 4). The purpose was again to place weather stations into a spatial context, but also provide a listing all weather stations, regardless of source, onto one site. The MashUp was built using the same process as the Webcam Viewer. Again, spatial attributes such as location, elevation, and source were also provided.

3.3 *Regional Data Viewer*

A final MashUp combines historical stream flow data from USGS stream gauges and precipitation data from NOAA Cooperative Observer Program (COOP) stations with a map display. Named the "Regional Data Viewer", the MashUp displays a map which the user can interact with, in a style similar to Google Maps. The locations of stream and precipitation stations are marked with dots on the map, and clicking on a dot will bring up a graph of stream flow or precipitation data from the corresponding station. The data graph is interactive, so the user can "pan and zoom" through time to view data from different time periods in order to compare the stream flow or precipitation from various events throughout the history of the station. Multiple graphs can be displayed on the map simultaneously, to allow comparisons between data from different stations, or between precipitation data and stream flow data for the same event (Figure 5). This provides the ability to visualize a large amount of data in a way that places it in a relevant historical and geographic context.

4. CONCLUSIONS

GIS and Geospatial Technologies have the potential to provide a variety of pertinent datasets and information in easy to use formats and accessibility to many different local and regional decision makers. With the spatial complexities of weather, climate and other environmental hazard situations, it is important for the decision maker to have access to these varied datasets and information. Having the appropriate data and tools is critical in order to perform operations in an effective and timely manner.

5. LINKS

Note that most of these products are currently still in beta versions housed on local machines at UNC Asheville and do not yet have permanent domain names. The exception is the Webcam

Viewer, which is now an official product. Feedback is greatly appreciated.

GIS Viewer:
http://hail.nemac.unca.edu:8399/WFO_GSP/mapviewer.jsf?width=693&height=512

Webcam Viewer:
http://www.weatherwebcams.org/

Weather Station Viewer:
http://ice.nemac.unca.edu/Renci/wnc_weather_stations_db.htm

Regional Data Viewer:
The Regional Data Viewer is currently a desktop program, but is scheduled to become a browser based program in winter 2009. Contact the author for more details.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

Camp, J.P. 2008. "Integrating a Geographical Information System into Storm Assessment: The Southeast Alabama Tornado Outbreak of 1 March 2007." *Proceedings from the 24th International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 88th Annual Meeting of the American Meteorological Society,* January, 2008, New Orleans, Louisiana.

Graffman I. and J. Kozimor 2005. "A GIS-Based Architecture for Integrating, Disseminating, and Displaying Weather Data." *Proceedings from the 21st International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 85th Annual Meeting of the American Meteorological Society,* January, 2005, San Diego, California.

Haberman, T., Cartwright, J., and R. Schweitzer 2004. "Integrating Science Data into Geographic Information Systems." *Proceedings from the 20th International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 84th Annual Meeting of the American Meteorological Society,* January, 2004, Seattle, Washington.

Rawles, M., Fransen, T., Salem T. and J. Adoplhson 2006. "Using GIS to Improve Real-Time Severe Weather Verification". *Proceedings from the 22nd International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 86th Annual Meeting of the American Meteorological Society,* January-February, 2006, Atlanta, Georgia.

Smith, T.A. and V. Lakshmanan 2006. "Utilizing Google Earth as a GIS Platform for Weather Applications." *Proceedings from the 22nd International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 86th Annual Meeting of the American Meteorological Society,* January-February, 2006, Atlanta, Georgia.

Stellman, K. and D. Welch 2003. "GIS Data and Applications at the Lower Mississippi River Forecast Center." *Proceedings from the 19th International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 83rd Annual Meeting of the American Meteorological Society,* January, 2003, Long Beach, California.

Waters, K.R. 2006. Weather Verification Using Geographic Information Systems. *Atmospheric Front, ESRI*, fall edition, 1, 7.

Waters, K.R., Coyne, J.M., Wolf, P.L., Schaefer, J.T., Looney, J.M., Naglic, S., MacAloney, B.W. II, and M.A. Tew 2005. "Polygon Weather Warnings – A New Approach for the National Weather Service." *Proceedings from the 21st International Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology, 85th Annual Meeting of the American Meteorological Society,* January, 2005, San Diego, California.

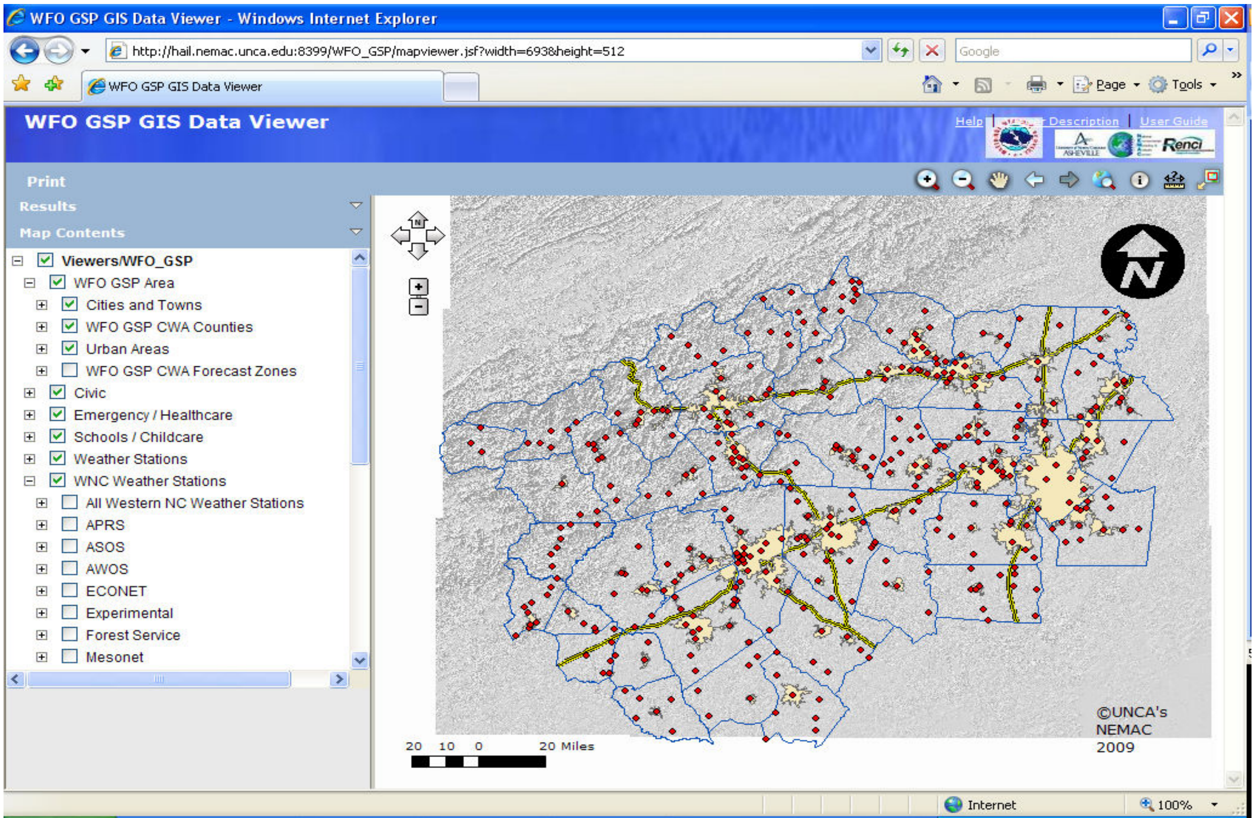

Figure 1. The GPS NWS "GIS Viewer", the current ArcGIS Server version. There are currently over 100 data layers embedded in this application.

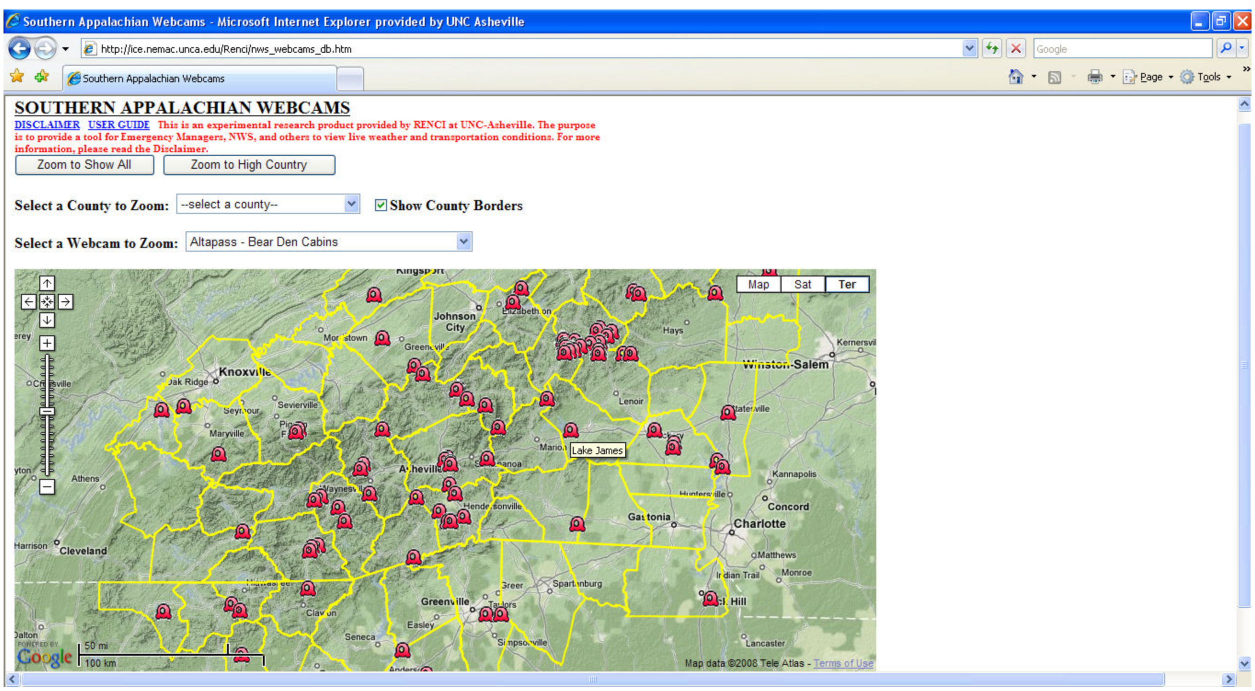

Figure 2. The "Webcam Viewer" MashUp for the southern Appalachian Region, which includes a large portion of the GSP NWS CWA.

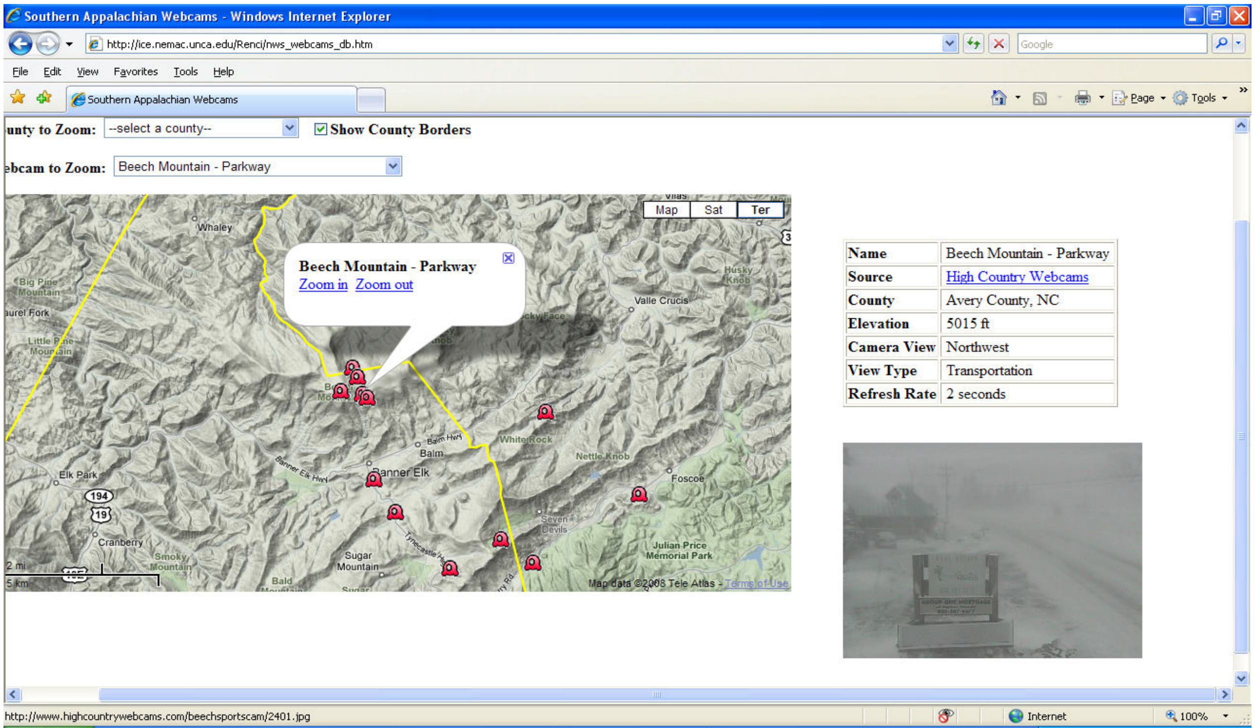

Figure 3. A selected webcam on the "Webcam Viewer" MashUp. Note the webcam attribute table and webcam image on the right. In this example, a decision maker can clearly see that roads are being impacted by snowfall.

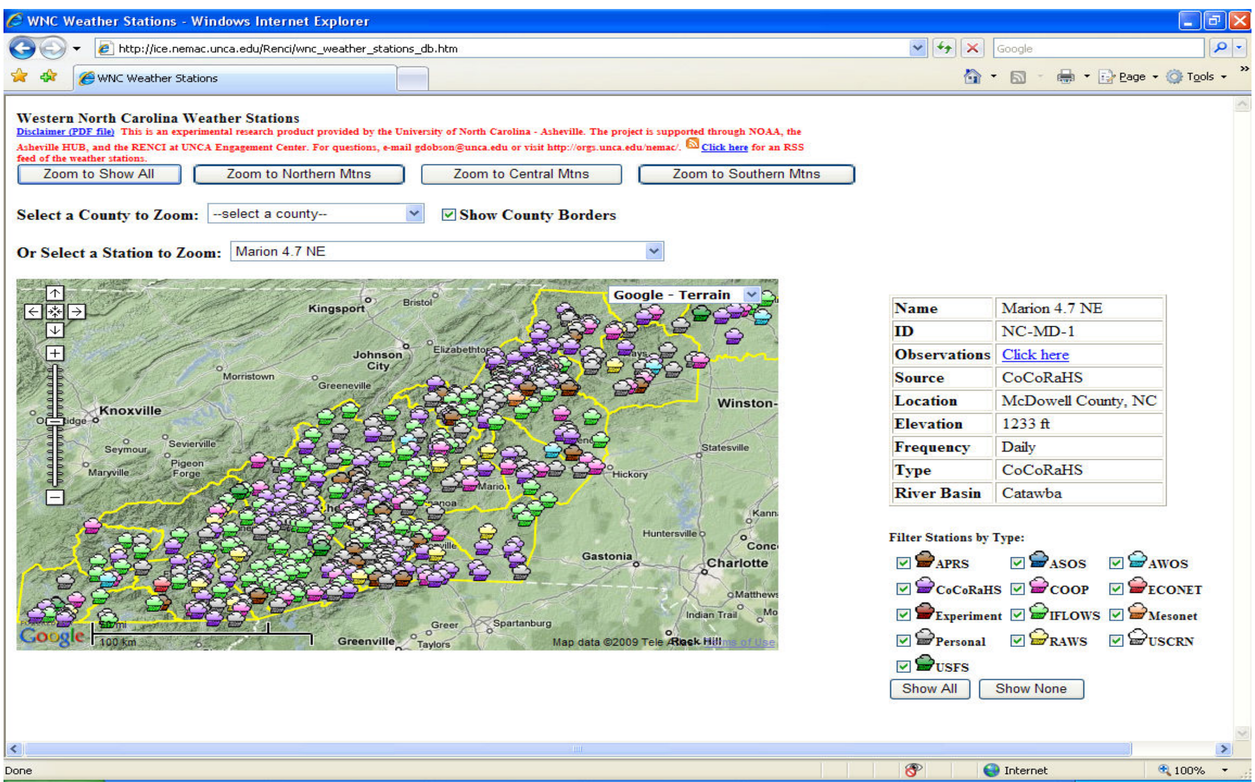

Figure 4. The "Weather Station Viewer" MashUp for Western North Carolina, which includes a large portion of the GSP NWS CWA. Note the option to filter weather stations by type.

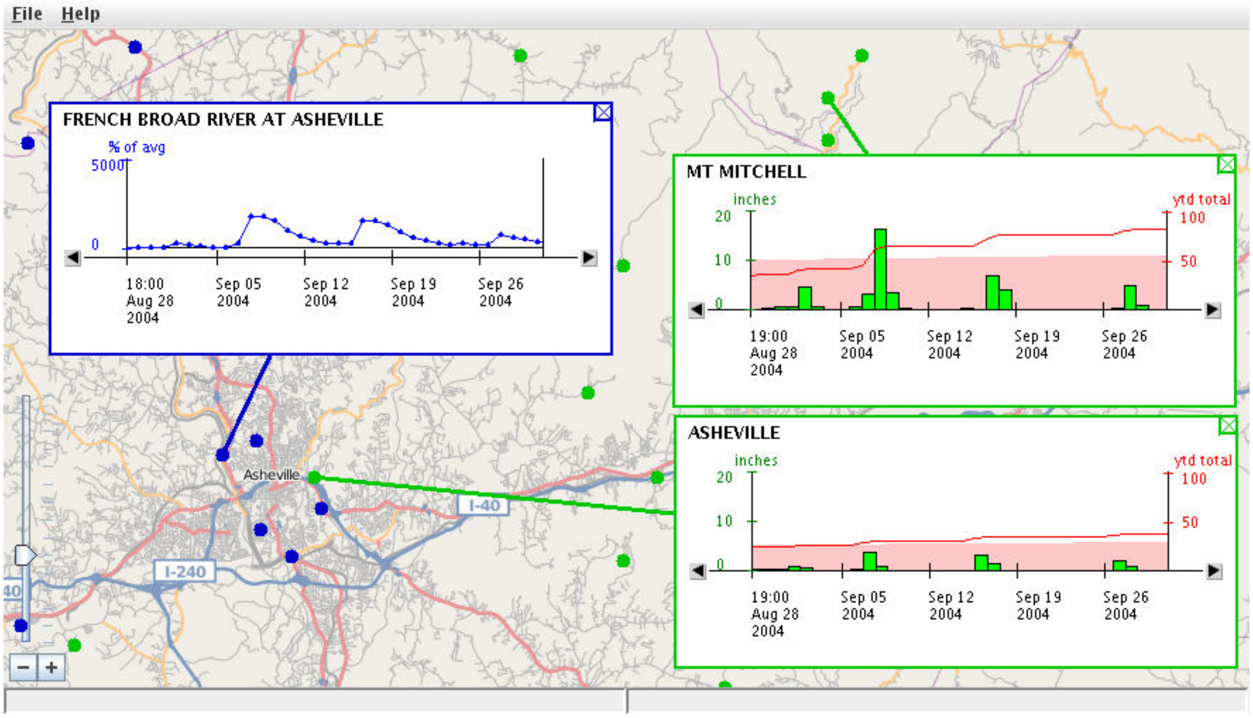

Figure 5. The "Regional Data Viewer" MashUp for North Carolina, displaying historical precipitation and stream flow data in graph format.