6.4 USING GIS FOR ENVIRONMENTAL DATA IN IOWA

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1. Introduction

The Iowa Environmental Mesonet (IEM hereafter) is a project at Iowa State University aiming to gather, compare, disseminate and archive environmental data from the state of Iowa. Geographic Information Systems (GIS) have provided the IEM an invaluable mechanism for data visualization and distribution. This abstract highlights some of ways the IEM is using GIS to distribute environmental data in Iowa.

2. Technical Components

Data arriving at the IEM servers come in many formats. None of these formats would be classified as a true GIS datatype. Via a handful of conversion scripts, the various data sources are eventually stored in a relational database. We choose PostgreSQL because of its open-source license and enterprise functionality. Within the database, PostgreSQL has an extension called PostGIS, which spatially enables PostgreSQL. With this extension, the PostgreSQL database can act as a backend spatial datasource for GIS.

With the IEM data in a spatial database, many GIS applications are able to dynamically query out data they need. The IEM uses a web-mapping GIS application called MapServer to produce web graphics and display query results. MapServer is an OpenSource environment for building spatially enabled web applications. Utilizing other OpenSource technologies, MapServer is a fast cross platform GIS.

The IEM also uses an extension to MapServer called MapScript. In particular, we use an extension to PHP to provide MapServer functionality in PHP. PHP is a popular scripting languauge used primarily for web development. The combination of PHP and MapServer creates a terrific environment to build GIS applications.

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3. MapServer Applications

To date, the IEM has produced over twenty web-based GIS applications using MapServer. It is our intention to continue to build more applications and refine the ones we have currently built. For the sake of brevity, we will highlight four of these applications.

a. Iowa Tornado Database

A climatology of tornado reports in Iowa was generated based on a dataset provided by the Storm Prediction Center in Norman, Oklahoma. This dataset was massaged and placed into a spatial database for further manipulation and display. MapServer easily combined this datasource with other GIS layers to produce a zoomable and queriable web application.

Using the configurability of MapServer, tornados with different strengths are segregated using different colors and 'killer tornados' can be individually plotted as well. MapServer also allows the user to query the generated image for individual meta-data about points (tornadic events) plotted in the image.

Tornado reports were the first step in our effort to convert other hazzards into a GIS database. Having the reports in a GIS container will open the door to many interesting comparisons. For example, a spatial correlation between tornado sitings and major roadways. It will also make the dataset much more available for other users in the state.

b. Where's it raining?

The IEM collects environmental data from local school networks operated by KCCI-TV (Des Moines, Ia) and KELO-TV (Sioux Falls, SD). These networks report live, up to the minute precipitation numbers to the IEM server. A process monitors this datafeed and generates 15 minute accumulations in real-time.

With the help of GEMPAK, another process converts recent NEXRAD imagery into GeoTIFFs. GeoTIFFs are TIFF format images with a spatial reference attached to them. Due to the lack of a tool to automatically do this conversion, scripts and rough fitting are used to spatially align the image to a projection.

MapServer, via a web interface, combines the NEXRAD imagery together with the 15 minute accumulations to produce a qualitative comparison of the base reflectivity product (#19) and accumulations. This application has been useful in cases of virga and general rainfall events. It is also helpful when it is not raining, since the accumulation will look suspect on the map.

c. NWS COOP Climatology

The NWS COOP database provides the official climatological record. Unfortunately, the formats distributed by NCDC are typically one-step away from being in GIS format. For many users, this first step is too large. The IEM, in many cases, acts as a data bridge between those with data and those needing data. Providing the NWS COOP dataset in GIS format is example of our mission.

With the help of the spatial database, the COOP data is easily queriable by MapServer and available for many other applications that connect to the database. Many of the resulting dataset plots provide an interesting picture of climatology. For instance, plotting the record low temperature for a day and the year of the record produces a plot showing the spatial distribution of temperatures and the year when it happened.

d. Data Map Generation

Visualization is a powerful tool for most types of story telling. In Meteorology, the theorem holds that a picture is worth a thousand words. For example, NEXRAD base reflectivity is represented with images and not textual tables. Many data users of the IEM are only interested in quick and clean data displays of a variable across the state, ie temperature.

With the help of an extension to MapServer called PHP MapScript, dynamic GIS plots are generated within seconds of the user's selection. Since the application is GIS based, it makes it very easy to incorperate other GIS layers such as road databases and river basins. For example, we have combined a NEXRAD reflectivity layer with a GIS layer containing NWS Weather Forecast Office (WFO) County Warning Area (CWA) shapes with current county and polygon warnings highlighted. This plot can be looped over time to produce an interesting look at cell propogation within a warning box.

4. GIS-ready NEXRAD imagery

The IEM was first exposed to GIS after receiving many requests for real-time NEXRAD information in various GIS applications. Users were most interested in viewing reflectivity products and NEXRAD precipiation estimations. After some investigation, we found it relatively easy to geo-reference reflectivity images and statically provide the data to users.

Some users are not able to handle imagery, so they wanted the NEXRAD data in ESRI shapefile format. NEX2SHP, an open-source encoder written by Scott Shipley, is currently being used to convert real-time imagery into shapefile format. Future versions of NEX2SHP will also include elevation information and the polygons of the NEXRAD shapes.

The real challenge has been how to stream this information to users in real-time and avoid the static downloads. It also seems difficult to include timestamp information with the products. We are looking for ways to meet these challenges in the near future.

5. Conclusions

Using the spatial extension, PostGIS, to the PostgreSQL database, the IEM has been able to distribute environmental data in the state of Iowa. With the help of MapServer, we have been able to generate dynamic GIS plots of datasets for fast and clean viewing by our users. Using PHP MapScript, an extension for MapServer, we

have been able to generate very customizable plotting applications and data visualization applications.

The IEM has just tipped the iceberg with regards to the use of GIS with environmental data in the Iowa. We are the first ones to admit that we are not using GIS to its full capability. As we continue to build partnerships and collaborations, new ideas to utilize GIS will formulated and it be exciting to see where our efforts take us.