J9.11 ARCVIEW APPLICATIONS IN USDA CROP WEATHER ANALYSIS

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1. INTRODUCTION

The United States Department of Agriculture (USDA), World Agricultural Outlook Board (WAOB) provides official government forecasts of agricultural commodities. These estimates are dependent upon meteorological variables such as temperature and precipitation, which influence crop progress, condition, and ultimately production during the growing season. Recently, WAOB meteorologists implemented operationally a geographic information system (GIS) to monitor changes in the weather relative to major crop producing regions worldwide. Several applications were developed to facilitate and automate data processing and display, improving meteorologist capabilities to identify and delineate crop areas of concern. These applications are presented, as is a brief description of the hardware, software, and data used in developing and implementing these applications.

2. SYSTEM HARDWARE AND SOFTWARE

WAOB meteorologists developed an agency GIS using Environmental Systems Research Institute (ESRI) Inc. ArcView 3.2 software installed on desktop personal computers and the WAOB local area network (LAN). Each desktop computer has a Pentium II processor, a processing speed between 450 and 900 MHz, between 256 and 512 MB of RAM, and is equipped with the Microsoft Windows 98 operating system. ESRI's Spatial Analyst 2.0 extension is installed on several desktop computers and the LAN, enhancing the functionality of the ArcView 3.2 software. A key component of ArcView 3.2 is the ability to develop customized applications using the Avenue programming language. Several of the applications presented in this paper use Avenue to automate data ingestion, processing, and display.

3. DATA

Several meteorological data sets are examined regularly to assess the impact of weather on global crop production. International crop progress and conditions are estimated using World Meteorological Organization (WMO) temperature and precipitation data. Similarly, domestic crop development is monitored using synoptic and cooperative observer data. All of these data are archived in the WAOB agricultural weather database management system (DBMS) and are readily accessible by the WAOB GIS via SQL calls (Morris 2001). Other meteorological data sets are examined less frequently, however, these data often play a significant role in assessing crop progress and conditions when extreme or severe weather is observed. Such data includes tropical cyclone coordinate data and data from various mesonetworks (e.g., SNOTEL, FAWN). Because these data are used irregularly, these data are not typically stored in the WAOB DBMS.

Another important group of data examined by WAOB meteorologists is various agricultural data. International and domestic crop production data are used to identify major and minor crop producing areas worldwide. These data help meteorologists focus crop weather monitoring efforts on only those regions that are agriculturally important. Additionally, domestic crop progress and condition data obtained from the USDA National Agricultural Statistics Service (NASS) are often examined to help augment these assessments.

4. PRODUCTS

4.1. *Daily plot maps*

Daily plot maps illustrate the observed maximum temperature, minimum temperature, and precipitation at point locations worldwide and are generated daily using WMO data. An ArcView Avenue script was developed to automate this process and requires that the user input only the date that maps are required. WMO data are imported into ArcView from the WAOB DBMS, formatted as text strings, and plotted as text labels on a map of the world. The script causes ArcView to pan and zoom to 23 areas on the map, and export a JPEG image of the zoomed-to area as a regional layout. An example layout for southern Asia is shown in Figure 1. These maps help analysts monitor daily changes in crop weather and quality control shaded contour analyses of these data.

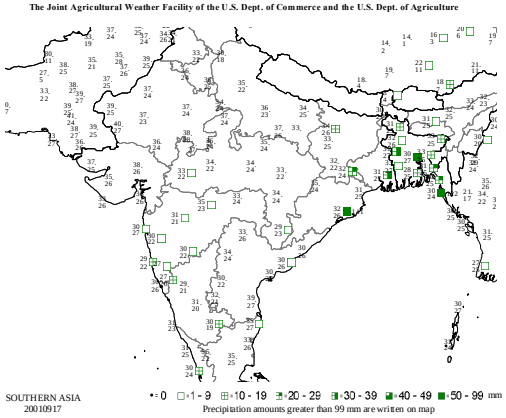

Figure 1. Daily data plot of southern Asia.

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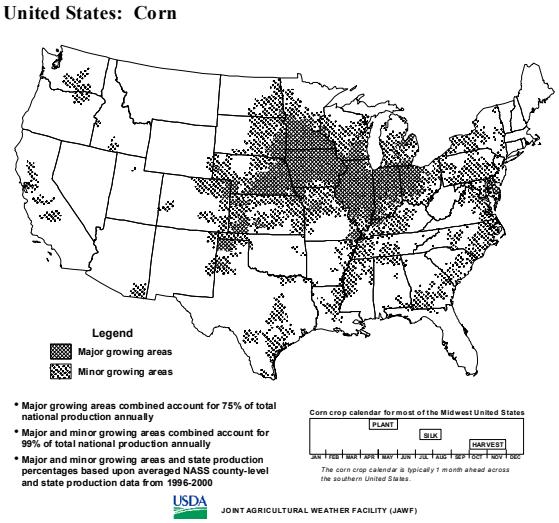

Figure 2. Major and minor U.S. corn producing areas.

4.2. *Shaded contour maps*

Shaded contour maps of temperatures and precipitation are generated regularly for 14 regions worldwide. The Avenue script that automates this process is an enhanced version of the daily plot script. In contrast to plotting the raw station data as text labels, spatial interpolation techniques are applied to point data to create the shaded contour maps. These analyses are exported as Windows Metafiles and are produced weekly, monthly, and seasonally.

4.3. *Crop area shapefiles*

United States crop maps are developed by joining tables of NASS county-level crop production data to the attribute table of the ESRI county shapefile. Major and minor crop producing areas are then delineated based on the crop production in each county normalized by the county area (Figure 2). Similar data are used to create international crop area maps when crop production data is available for comparably sized administrative regions. Weather data are often overlaid crop area shapefiles in the GIS, enabling meteorologists to identify the temporal and spatial extent of favorable or unfavorable weather in major crop producing areas.

4.4. *Crop progress and condition maps*

NASS crop progress and condition data are downloaded from the Internet weekly and formatted into ArcView-compatible files using a Microsoft Excel Visual Basic Application. These data are then imported into ArcView, visualizing crop progress and conditions across the United States (Figure 3). Crop progress analyses help meteorologists identify those time periods when crops are most sensitive to the weather, while crop condition analyses help economists forecast total crop production.

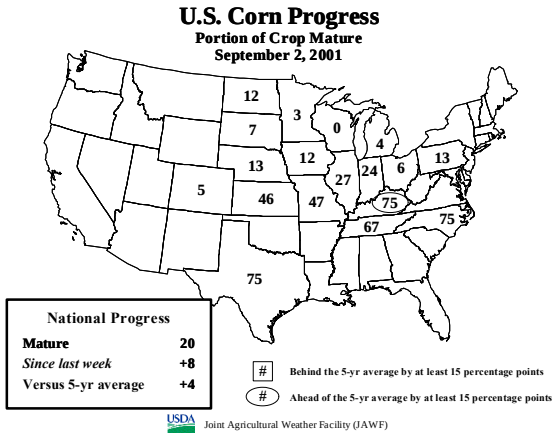

Figure 3. Sample United States corn progress map.

4.5. *Special analyses*

Occasionally special crop weather assessments are prepared in response to extreme or severe weather. Many of the data sets described above are combined in the GIS to develop a comprehensive understanding of these events. Additional, less frequently used, data sets are used in these analyses as well. For example, point rainfall estimates, rainfall contours, crop area shapefiles, crop progress data, and hurricane coordinate data have been overlaid in the GIS when hurricanes have struck cotton-producing areas in the southeastern United States. Similar analyses have been prepared when other extreme weather events such as flooding rains, droughts, freezes, and extreme heat have occurred.

5. DISCUSSION

The WAOB GIS has become a valuable tool for WAOB meteorologists, providing an effective platform for displaying and analyzing multiple agrometeorological data sets. The success of this GIS is attributed to 1) the ability to display and analyze weather AND numerous other types of spatial data simultaneously, and 2) the flexibility of ArcView, enabling users to develop and tailor applications that meet their specific needs. Given the value of GIS in preparing crop weather analyses, WAOB is currently upgrading their GIS software to ArcGIS 8.1 to expand their analytical capabilities. New projects are currently under development as well, including the development of GIS-based crop and soil moisture models.

6. REFERENCE

Morris, B. P., 2001: Meteorological database management system at the U.S. Department of Agriculture. Preprints, *18th International Conf. on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology,* Orlando, FL, Amer. Meteor. Soc.