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Topic (iii): Internet and Intranet solutions

VISUALIZATION OF THE 1999 CORN CROP SEASON IN THE UNITED STATES

Submitted by United States Department of Agriculture[1]

Contributed paper

I. INTRODUCTION

1. In tune with the theme of this workshop on the integration of statistics and geography, an operational example of monitoring corn crop condition and yield across the United States will be presented. The National Agricultural Statistics Service has the mandated responsibility for all official agricultural statistics in the United States, including the Census of Agriculture which is conducted every 5 years (1997 being the most recent). The major tools used to measure U.S. agricultural output are scientifically selected sample surveys from a nearly complete list of farm operators and from parcels of land in an area sampling frame. Among the more recently added supplemental tools used for only a small but growing portion of the program are geographic information systems and the utilization of remotely sensed data.

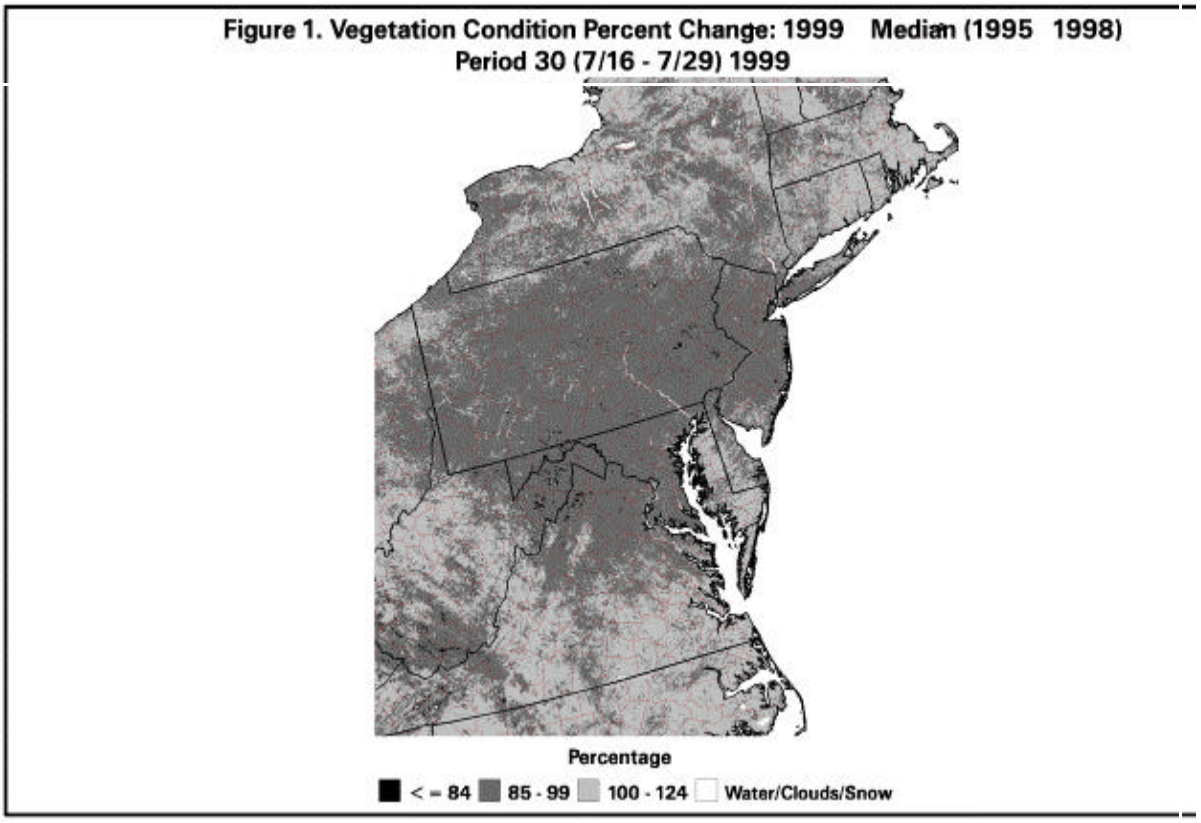
2. As with most seasons, the 1999 crop season had some substantial geographic variability primarily due to weather effects. The use of GIS and remotely sensed data and sample survey data will be used in this document to illustrate the geographic variability in the corn crop yield statistics in the U.S. in 1999. The graphic illustrations involve a mix between Internet and Intranet products depending on the nature of the data involved.

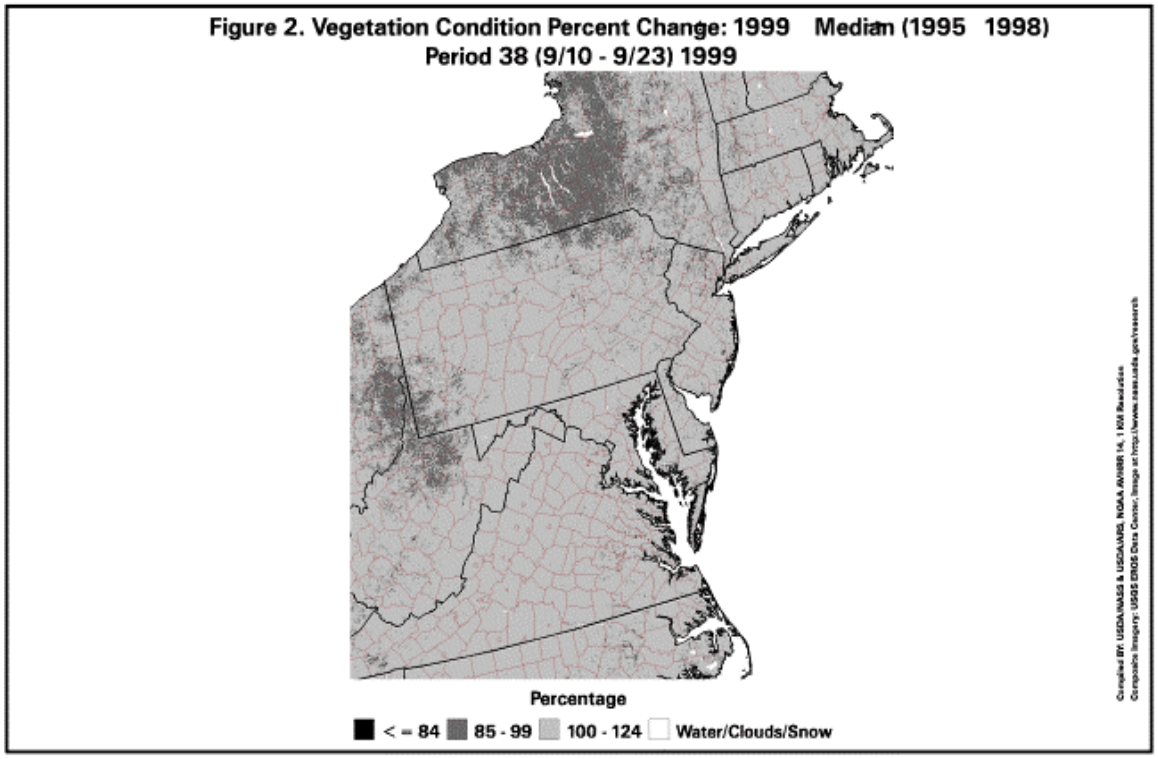
II. CORN YIELD VARIATION DUE TO GEOGRAPHY AND WEATHER

3. The corn season began with generally favorable weather for planting and plant emergence across the growing area of the United States. As the season progressed though, a serious drought developed in several of the mid-Atlantic states (Maryland, Delaware, Virginia and New Jersey) and Pennsylvania and spread even further north to New York and west to portions of Ohio, Indiana, West Virginia and Kentucky in July and August.

4. A drought during the months of July and August combined is usually quite damaging to corn yields as the corn ear fertilization and development is critical during that time frame. The first image (Figure 1) that follows shows the widespread vegetative stress over Pennsylvania, New Jersey, Maryland, northern Virginia, and northeastern West Virginia. The time period reflected in this image is July 16-July 29, 1999 as compared to the median of 1995-1998 for the same two week period. The ratio of the current year normalized difference vegetative index (NDVI), from the NOAA-14 polar orbiting weather satellite, to the median of 1995-1998 is shown. Figure 2 shows that the vegetative condition recovered quite well in this same area, due to substantial rains from the outer portion of several hurricanes, but too late to provide much relief for the corn crop. This type of graphic is put on the USDA/NASS Web site every two weeks from April 1-October 30. The USDA/NASS Web site address is *http://www.usda.gov/nass*.

[1] Prepared by George Hanuschak and Gail Wade.





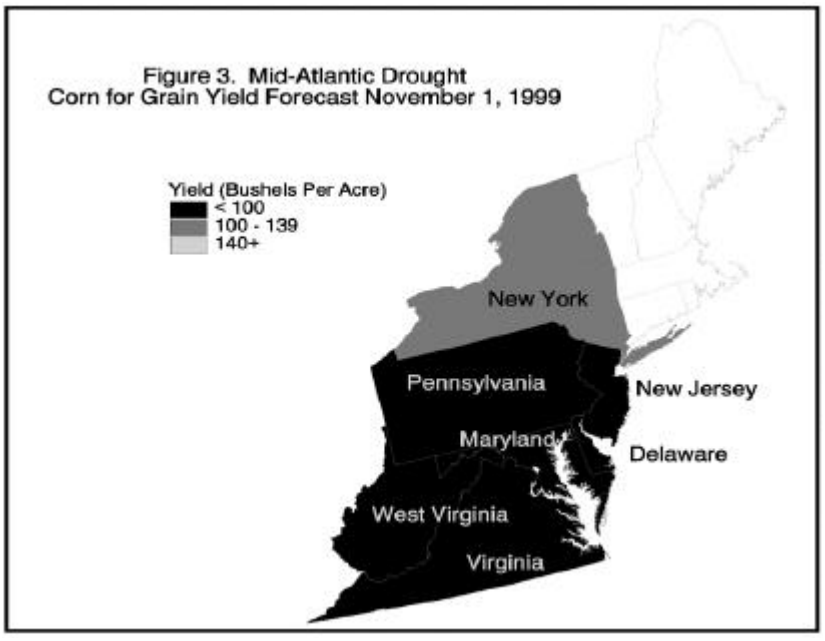
5. It is, also, important to realize the role of the metadata released with the image products. The products alone, the ratio maps, are sometimes insufficient to represent crop condition and is certainly not designed to directly reflect crop yields. Just discussing crop condition, for the moment, there are several reasons why the maps do not directly represent the condition of a specific crop, such as corn. Among the reasons are: the spatial resolution of the image data is one square kilometer which can be composed of several land covers or crop types; there are sometimes clouds or other atmospheric interferences such as haze or smoke; the NDVI vegetative index is related to plant chlorophyll (when atmosphere is clear) and

not necessarily fruit health, such as a corn ear; the stage of the crop development differs from year to year and doesn't necessary follow a julian date calendar period. For example, some years the crop is planted early, the average time, or late, often depending on the weather conditions. This is why there is extensive metadata and links to other NASS data, such as weekly crop condition reports from agricultural experts around the country. Both data sets are tracking similar events and both data sets have strengths and weaknesses. When both data sets agree, there is increased confidence in any conclusions one might draw from the weekly data.

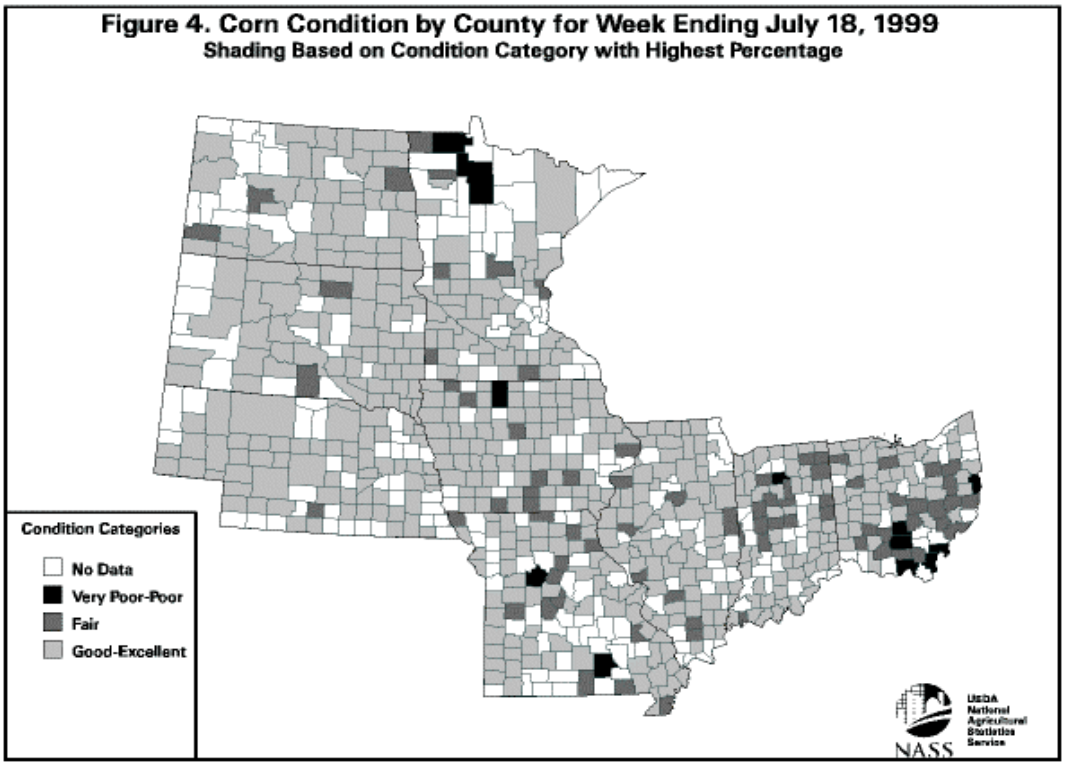
6. Even with the mentioned limitations, several quite important large area events have been displayed accurately, and perhaps more importantly early, such as the massive1993 flood in the U.S. Midwest damaging the U.S. corn and soybean crop yields, the cold, windy, dry winter and early spring drought in the U.S. southern Plains in 1995/96 damaging the winter wheat crop yields, the drought in Texas in 1998 damaging summer crop yields, the bumper crop conditions for winter wheat in the southern Plains in 1997/98, and the mid-Atlantic drought in 1999. When the imagery is free from atmospheric interference and there is a large area event and plant vigor or plant stress is highly related to eventual crop yields, the maps are quite informative to U.S. policy makers, such as the Chief Economist of the USDA, as an early warning device and in outlining the areas effected.

7. For crop yields (forecasted monthly), NASS uses considerably more sophisticated survey methods. Scientifically drawn samples of farm operators are drawn and farmers report their forecasted yield for their farms. In addition, scientifically designated samples of plots (small areas) within crop fields are drawn and field survey personnel visit the plots monthly and record plant counts, crop row spacings, crop fruit size and shape measurements, such as corn ear length and diameter. At the end of the season, crop cuttings are done and sent to a regional laboratory for crop weight and moisture measurements and final realized crop yield calculations. As Figure 3 shows for the mid-Atlantic area, as of November near harvest time, the forecasted crop yields developed from sophisticated survey data were indeed low.

8. Back to the GIS aspects, besides the metadata, the images are done in ARCINFO GIS then presented on the NASS Web site as 256 color (8 bit) GIF files. Users can select national images from any bi-weekly period from 1995 - current and historic comparisons to previous year starting with 1996 and historic comparisons to a three year median (1995-1997) starting in 1998. There are also thumbnail image prints for a quick look at the entire season to date and several "zooms" into specific events of interest, such as the mid-Atlantic drought of 1999.



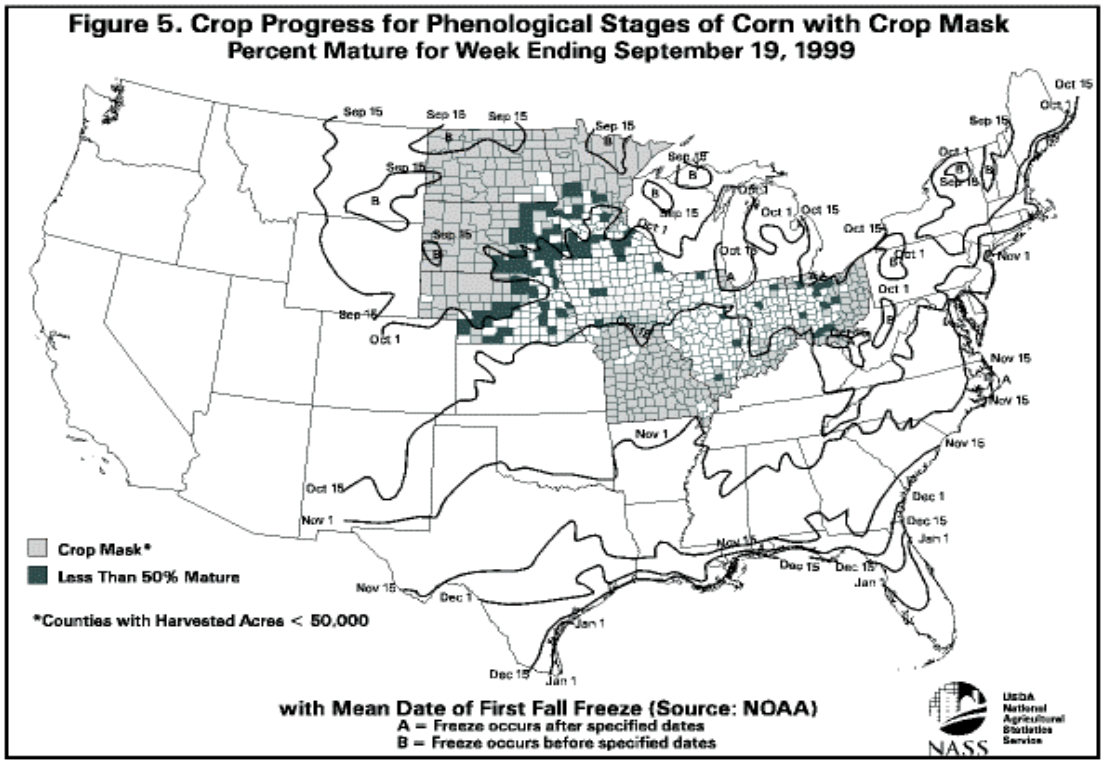
9. Figure 4 shows that corn crop conditions, reported as of July 18, primarily by county level agricultural experts reflect that while the mid-Atlantic states were in poor condition shown previously in Figure 1, corn condition was generally quite favorable across many of the major producing areas in the Midwest. Thus these type of GIS generated theme maps demonstrate the geographic variation, due primarily to weather variation, of the corn crop conditions.



10. Figure 5 shows, for the same Midwest U.S. area, that the corn crop was virtually mature as of September 19 and not very vulnerable to any fall freeze. The 30-year average first fall freeze date contours, from the U.S. National Oceanic and Atmospheric Administration (NOAA), are overlaid on the corn crop progress (or maturity) by county in ARCINFO GIS and then displayed as a graphics file.

11. Figures 4 and 5 are part of an Intranet version designed for NASS crop analysts in Washington, DC and 45 State Statistical Offices. A public version (at the agricultural statistics district level approximately 10 counties aggregated) is being evaluated for eventual release on the NASS Internet site.

12. So far, NASS GIS analysts have asked internal and external users for feedback on the type of GIS graphics associated with crop monitoring that they, the users, desire. So far, users have preferred that we design the graphics for them and post them to the Internet or Intranet for them. We would also like to provide a user designed interactive Web graphics system working off a database, but so far the infrastructure investment hasn't been initiated. NASS is working with Cornell University to provide a user driven interactive Web graphics system for the Census of Agriculture data initially.



III. SUMMARY

13. Geographic information systems (GIS) systems software has proven useful to help illustrate the geographic variability of crop production statistics in the United States. Even though the form of the GIS graphics are quite simple in nature, the importance of the underlying agricultural statistics bring value to the GIS displays which show geographic variations, often due to weather and climate variations. Thus, in tune with the theme of this workshop on the integration of statistics and geography, the U.S. corn crop geographic variation in 1999 is illustrated.

IV. ACKNOWLEDGMENTS

14. The authors, George Hanuschak and Gail Wade of USDA/NASS, would like to express their gratitude to Michael E. Craig, Ron Bosecker, Rich Allen and Fred Vogel of NASS for their management support of this activity and the nine State Statistical Offices of NASS that provide the data for the Intranet version products.