Synagraphic Mapping of the Mean Elevation and Relative Relief of Indiana

JERRY E. HASCH and THOMAS W. HODLER
Department of Geography
Indiana University, Bloomington 47401

Abstract

Mean elevation and relative relief data were chosen from the 698 U.S.G.S. topographic maps comprising the state of Indiana. These data were used in Synagraphic Computer Mapping to construct 1:1 million scale mean elevation and relief maps of the state. The mean elevation map was divided into 5 zones: 333-502, 502-672, 672-841, 841-1011, and 1011-1180 feet; whereas the relative relief map zones were 20-141, 141-262, 262-382, 382-503, and 503-624 feet. Production time necessary for the two maps was only 70 man-hours.

Introduction

Small-scale maps depicting elevation and relief conditions of relatively large areas long have been used in teaching geography and geology, and as standard presentations in textbooks, atlases, wall maps, and journal articles. Among the common graphic techniques employed have been contour lines, altitude tints, black-and-white screen patterns, physiographic symbols, hachure marks, and pictorial shading.

Regardless of technique, all such maps face a common problem; significant differences or similarities of land surfaces are difficult to portray because of the high degree of simplification required at such a small scale. For example, Kingsbury (2) used a black-and-white page size (8½ x 11 inches) map of Indiana topography with only five contour lines at 400, 600, 800, 1000, and 1200 feet above sea level. While further contour lines on this map would have been more desirable, they probably would have detracted seriously from the reader's use of the map. Nevertheless, this contour interval is far too large to portray anything but highly generalized elevation zones.

In a course in cartography at Indiana University, the use of computer mapping was discussed. Among the programs considered was Synagraphic Mapping, a computer program whose maps were produced on an alpha-numeric printer rather than a line plotter.

Map output in the form of letters and numbers rather than conventional lines, colors, or screen patterns offered the opportunity of experimenting with distinct types of elevation and relief maps. It was reasoned that small-scale Indiana maps with computer-made patterns might create graphic products which were considerably more meaningful and useful than those using conventional techniques.

Methods

Computer Program

Synagraphic Mapping or SYMAP is a computer program for producing certain types of qualitative and quantitative distribution maps. Originally conceived in 1963, more recent improvements and developments in the program have come from the Laboratory for Computer Graphics, Graduate School of Design, Harvard University. The program is written in Fortran IV and is available as a source deck of approximately 5,000 cards or on tape.

Since SYMAP products come from the alpha-numeric printer, overprinting of letter combinations were used to produce increasingly darker patterns. Thus, the solid black areas on Figures 1 and 2 were made by overprinting A, O, V, and X.

Five printer patterns and five data zones were used in both sample maps. Increasingly darker printer patterns on a gradational basis are used to show increasingly higher data zones. While the program will accommodate ten data zones, our experimentation suggests that five is about maximum. Beyond five data zones, the printer's symbolization choice is insufficient to produce clear and distinctive gradational zones.

In brief, these types of data are discovered and fed to the computer on separate punched cards: 1) outline points delineating the area to be mapped; 2) data point locations within the area (and outside the area where they are to be used for calculations); 3) data point values. All outline and data points are punched as X and Y coordinates in tenths of inches from an upper-left origin point; these are generally calculated from an existing selected base map (1).

Each of the sample Indiana maps required 1,493 punched cards—97 for the outline of Indiana, 698 for the data point locations, and 698 for data point values. The mapping was accomplished by the CDC 3400-3600 system at the Research Computing Center, Indiana University.

Mapping

Mean elevation and relative relief were mapped in this study. Both maps were based upon data obtained from the 698 published U.S. Geological Survey 7½ minute (1:24,000) topographic quadrangles for Indiana.

The highest and lowest elevations were taken from each quadrangle map. These two elevation readings were averaged to derive a mean elevation value. The difference between the highest and lowest elevations constituted the relative relief within the area and each topographic quadrangle.

For example, on the Columbus topographic quadrangle the highest elevation was 745 feet and the lowest was 585 feet. Therefore, the mean elevation was 665 feet above sea level and the relative relief was 160 feet.

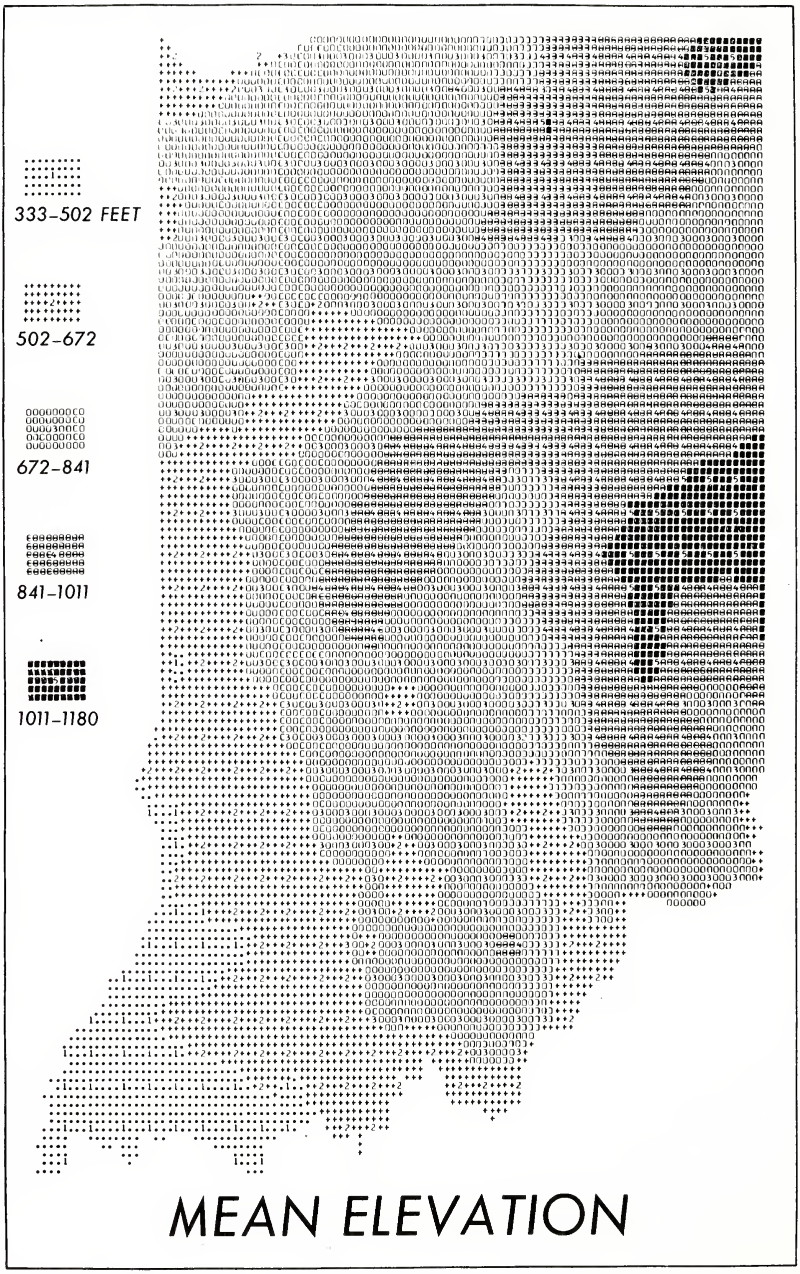

FIGURE 1. *Mean elevation map of Indiana produced by the Synagraphic Mapping Technique.*

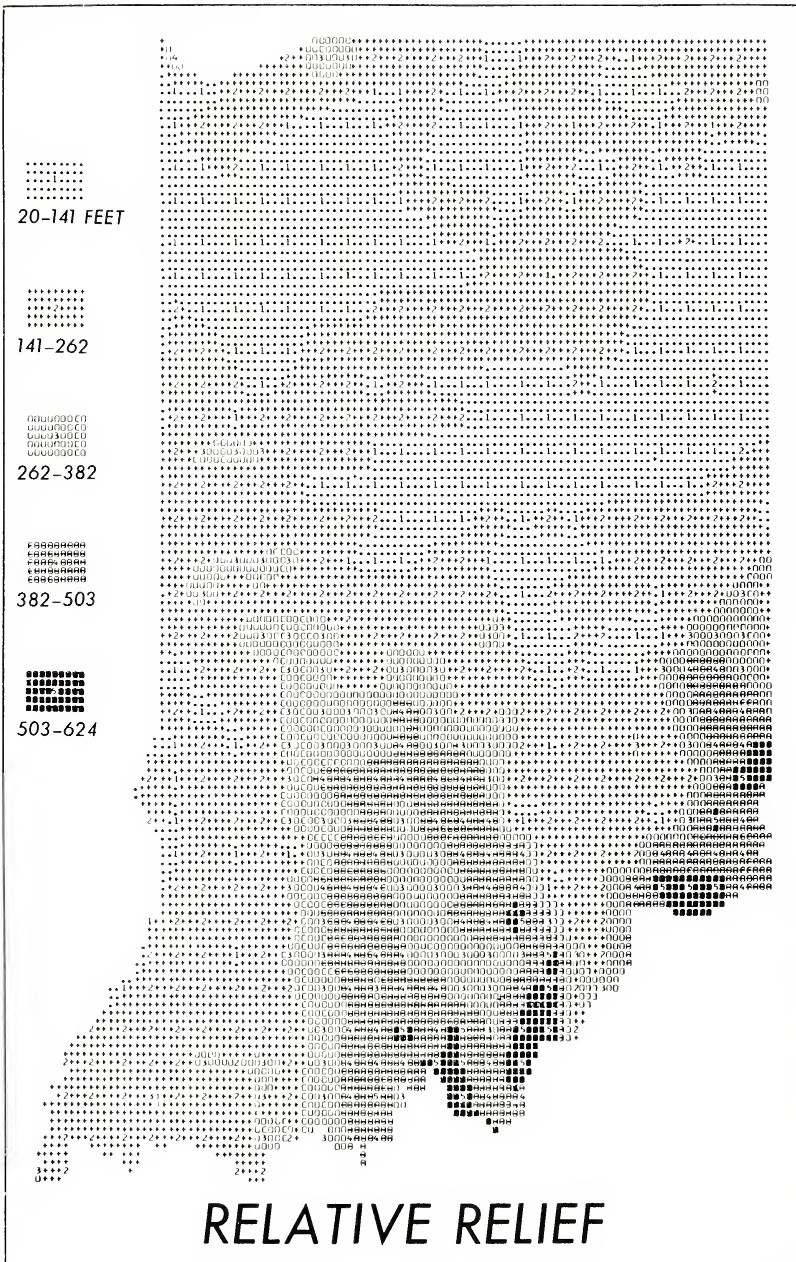

FIGURE 2. *Relative relief map of Indiana produced by the Synagraphic Mapping Technique.*

Results

The base map used for the final product was the 1:1,000,000 scale *Index to Topographic Maps of Indiana* published by the U.S. Geological Survey (4). In its original size, each of the 698 topographic quadrangles appears as approximately 0.42 inch x 0.54 inch. Each is a rectangle of 24 computer printer symbols. Data point locations for each map are approximately centered in this printed rectangle. The samples presented here are reduced approximately 66% from their original computer printing.

The map depicting the mean elevation data for Indiana was divided into five separate zones (Fig. 1). Each zone contains 20% of the absolute value range. Since data extremes are 333 feet and 1180 feet, the absolute value range is 847 feet. The range of the lowest classification is from 333 to 502 feet. The range of the next group is from 502 to 672 feet. The progression continues until the darkest pattern or highest zone contains the top 20% of the absolute value range.

Relative relief in the state is shown by Figure 2. It was constructed using the same five symbols to represent five separate data classes. Here too, each zone contains 20% of the absolute value range. The extremes for this map are 20 feet and 624 feet or an absolute value range of 604 feet. The range of the lowest zone is 20 to 141 feet, the second zone, 141 to 262 feet, and so forth as shown by the map legend. Since the two lowest zones contain nearly ¾ of all data values plotted, there is less than 262 feet of relative relief in 75% of Indiana.

Data point locations are shown on the maps as numbers representing the symbol classes into which they fall. Thus, on the relative relief map, the Columbus quadrangle which falls in the range of 141 to 262 feet is placed in the second absolute value class. Centered in this quadrangle location on the computer map is a number "2."

The production time necessary to achieve the final results was approximately 70 man-hours: 33 hours for data collection, 11 hours for tabulation and calculation, and 26 hours in transferring data to computer cards.

Discussion

Although the compilation work is laborious, the SYMAP program is extremely useful for experimenting with different versions of the same map or different approaches to the same problem. The ability of the program to manipulate data and produce, as a result, radically different graphic portrayals may well be the program's greatest asset. Once the initial map information is available on punched computer cards, a change of a single card, or at most, five cards, will yield quite differently appearing maps.

While the maps illustrated divide the data into classes based upon percent of value range, a single card change can produce maps which divide the data into classes based upon the number of data point locations. Another simple change in cards can establish any desired numerical value zones. Thus, the relative relief map (Fig. 2) with extremes of 20 and 624 feet, can be made with these or any other desired zones: 0-100, 100-200, 200-300, 300-400, 400 and above.

While our examples placed 20% of the data in each of the 5 zones, any percentage may be placed in any of up to 10 zones. Further, if it is desired, high values, or low values, or any part of the values may be eliminated from the map produced. Again, any of these changes can be affected by quick and simple card changes. Experimentation possibilities using the same data appear almost endless.

This graphic technique is far more accurate than conventional means. Detail is essential in most maps, and SYMAP offers this accuracy of detail. For example, Figure 2 depicts quite accurately the "Knobs" area around New Albany, the Brownstown Hills, and the morainal area of northern Indiana.

Data of many types may be used in synagraphic mapping. Although mean elevation and relative relief were chosen here to communicate the usefulness of SYMAP, other quantitative data, such as population density or distribution, works equally well with the program.

Synagraphic mapping is a relatively new approach in graphically portraying old problems. The technique offers the user unusual computer printer patterns. It also allows the user to manipulate the data and observe the results in a short period of time.

Literature Cited

1. Harvard University. Laboratory for Computer Graphics. n.d. Reference manual for synagraphic computer mapping, version V. 60 p.

2. KINGSBURY, ROBERT C. 1970. An atlas of Indiana. Geog. Dept., Indiana University, Bloomington, Occas. Pub. No. 5. 94 p.

3. ————. 1969. Experimenting with version V of the SYMAP Program. Geog. Dept., Indiana University, Bloomington. 15 p.

4. United States Geological Survey. 1970. Index to topographic maps of Indiana. Washington, D. C. 4 p.