SLOPE STUDIES OF NORTHERN ILLINOIS

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In recent years considerable interest has arisen in the quantitative expression of differences and similarities of terrain from region to region.[1] However, most of these studies have been primarily concerned with a technique or method of analysis and representation, and have generally been exemplified by a single area. The applicability of these methods to various types of terrain and a comparison of results obtained from different landform regions has been largely, though not entirely, neglected. Moreover, none of the papers has presented any appraisal of the results of such investigations in terms of the results or, more especially, of the results as evaluated in terms of the number of data required and the time involved in their analysis. This paper reports results from the utilization of only two techniques, neither of them new.

Relative Relief

The first method is one introduced by Guy-Harold Smith in a map of "The Relative Relief of Ohio."[2] The method of calculation is simple. From topographic maps of an area the difference between the highest and lowest point in each five-minute rectangle is ascertained. These values are then entered on the manuscript map and isolines are drawn connecting the center of all rectangles having the same values.

Two areas in the United States have been mapped using this method —the state of Ohio by Smith[3] and the Driftless Area of Minnesota, Wisconsin, Iowa, and Illinois by Smith and Trewartha.[4] The Driftless Area contains areas of low relief on its margins, and Smith and Trewartha, by shading heavily the critical relief range were able to show strikingly that the borders of the Driftless Area coincided remarkably well with a particular local relief range. Western and northwestern Ohio have very considerable areas of moderate or slight relief and these, of course, were represented on Smith's map of the state. However, in both of these areas sections of low relief made up only a small part of the total area.

The principal objective in applying the method to northern Illinois was to determine from a comparative study of the various relative relief maps produced and the topographic maps of northern Illinois what results could be obtained in the representation of smaller differences in local relief in an area of predominately low relief.

Figure 1 shows the local relief of northern Illinois using the method developed by Smith and using the same relief value limits. Five conclusions can be reached almost im-

[1] A large number of these studies are summarized and discussed in: Louis A. Wolfanger, *Landform Types*, Mich. Agric. Exp. Sta. Tech. Bull. 175, East Lansing, Mich.

[2] Guy-Harold Smith, "The Relative Relief of Ohio," *Geog. Rev.*, Vol. 25, 1935, pp. 272-284.

[3] *Ibid.*

[4] G. T. Trewartha and G.-H. Smith, "Surface Configuration of the Driftless Cuestaform Hill Land," *Annals Assoc. of Amer. Geographers*, Vol. 31, 1941, pp. 25-45.

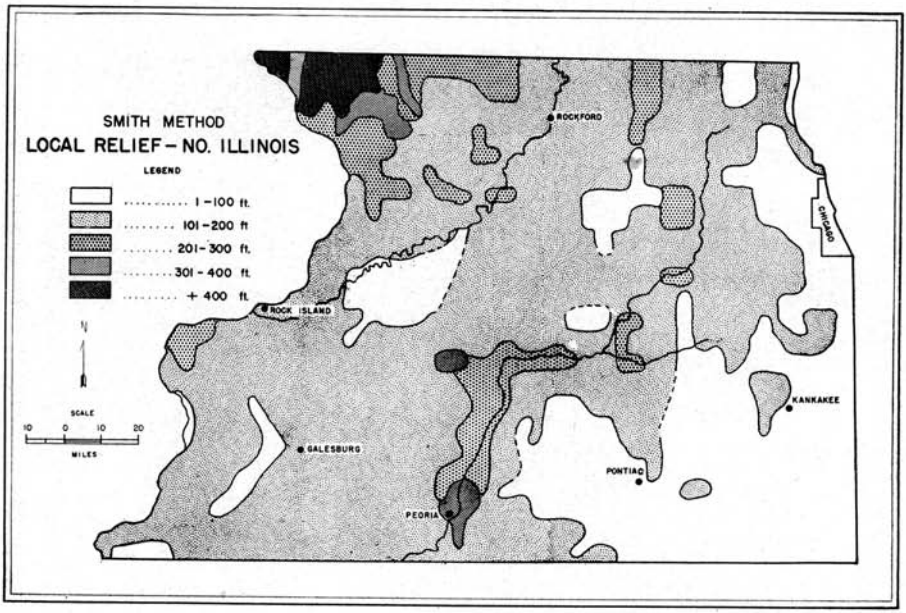

FIG. 1.

mediately from the most cursory inspection of the map: (1) the overwhelming preponderance of the land in northern Illinois has less than 200 feet of local relief; (2) the glacial lake plain of Chicago, much of the Kankakee River drainage way, and the Grand Prairie area have very low relief—less than 100 feet; (3) the only section of northern Illinois having strong relief is the Driftless Area in the extreme northwest corner of the state; (4) lands immediately adjacent to the Middle Illinois Valley have moderate local relief, and (5) the outwash plain south of the Rock River in the Prophetstown area and eastward is an area of low relief.

Very little else of value can be ascertained. The tongue of moderate relief (201-300 feet) extending southward from the northern border west of Rockford undoubtedly reflects the influence of the Marengo moraine but it is wider than the moraine and bears little relationship to its form. The compact area west of the Fox River occupies part of the morainic knot in central Kane County but it bears no significant relationship in either shape or size to the terrain situation in the area viewed either in the field or on topographic maps. The greatest relief in the southern part of the map occurs where the Bloomington moraine crosses the Illinois River valley. Other minor features have even less significance.

In calculating local relief from contour maps having a 20-foot contour interval it is obvious that there will be more rectangles having values that are multiples of 20 than are multiples of 10 only. In the construction of any isopleth map it is better to use value limits that have a low frequency than limits having a high frequency of occurrence. Another map was constructed using 90 feet and 190 feet as the value limits

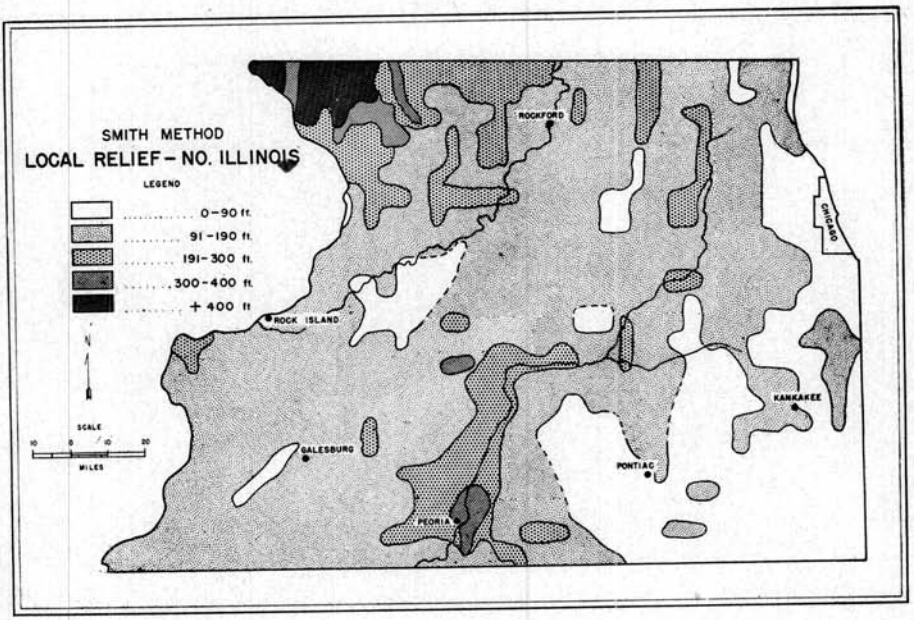

FIG. 2.

instead of 100 and 200 feet (fig.2). All the major generalizations apparent on the first map are equally apparent on figure 2, but the borders of the major areas and the shapes and sizes of many of the minor areas are quite different. Some of the new outlines of these minor areas seem to be more meaningful in terms of portraying actual terrain conditions; about an equal number appear less so.

Once the local relief values have been entered on the base map any number of relative relief maps can be constructed on overlays using any relief value limits that are desired. Several other local relief maps using various relief value limits were constructed. Several of them had much lower value ranges. On all the maps the main outlines of local relief conditions in northern Illinois were clear; on none of them, in the author's opinion, were minor features any more satisfactorily portrayed than on the maps illustrated.

Smith and Trewartha have suggested that experimentation be made to discover a particular size rectangle that will portray conditions more satisfactorily in any particular region than would either a larger or smaller rectangle. The author carried on no experiments of this kind, because of his conviction that whatever was gained in the portrayal of local areas by varying the size of the rectangle would be more than offset by the greatly added difficulties to inter-regional comparison that would certainly result from using a variety of different sized rectangles from region to region.

AVERAGE SLOPE CONDITIONS

An isarithmic map of average slope can be constructed for an area in a manner similar to that of a map for relative relief except that values

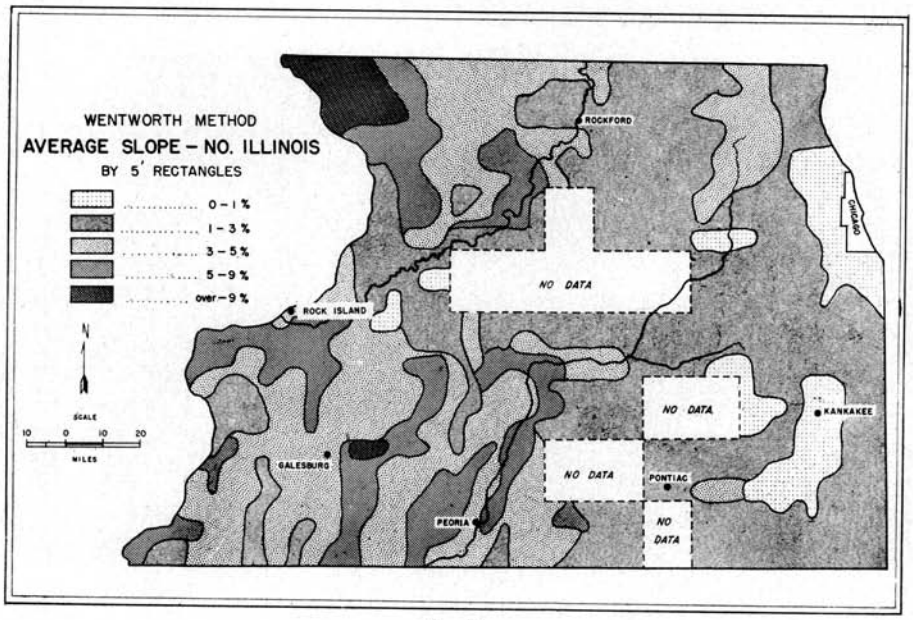

FIG. 3.

for average slope of a 5-minute rectangle as calculated by a method promulgated by Wentworth[5] are used instead of local relief. It must be kept clearly in mind, however, that the two concepts are not the same. It is possible for an area to have strong local relief and comparatively low-angle slopes, or conversely for an area to have low local relief and high-angle slopes.

Figure 3 shows a map of northern Illinois constructed by this method. No sharp general conclusions are immediately apparent. The Chicago lake plain shows up as an area of very low slopes as does a small section around and south of Kankakee. The extreme northwestern area is the only large division having steep slopes. In a very general way it may be noted that the areas flanking the three major rivers of northern Illinois—the Rock, Mississippi, and Illinois—have somewhat steeper slopes than the areas farther removed from these valleys. But with the exceptions just noted, the pattern appears to bear no significant, visible relationship to actual slope conditions in the area portrayed.

In the average slope maps, however, a somewhat better map may be produced by using other slope value limits. In figure 4 the Chicago lake plain is much more satisfactorily delimited and the southeastern corner of the map stands as a clear-cut single area having universally low-angle slopes. Moreover, the morainic belt circling the south end of Lake Michigan stands out quite clearly from the flanking areas of smoother terrain. There is a much stronger suggestion of the smooth outwash plain south of the lower Rock River. Elsewhere on the map the representation seems no better or no worse than that in figure 3.

[5] C. K. Wentworth, "A Simplified Method of Determining the Average Slope of Land Surfaces," *Amer. Jour. of Science,* Series 5, Vol. 20, 1930, pp. 184-194.

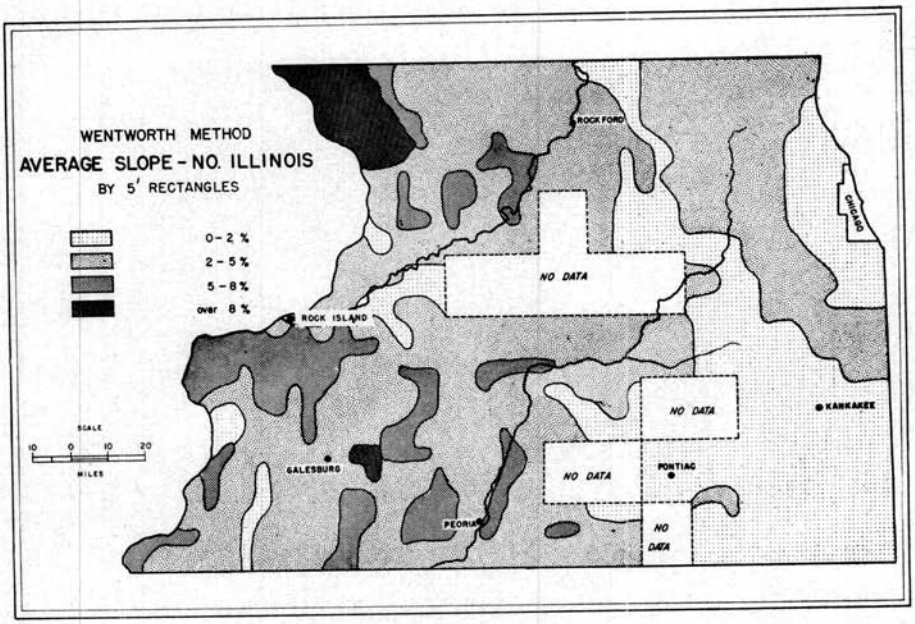

FIG. 4.

EVALUATION OF RESULTS

The local relief method of expressing quantitative differences in terrain appears to be a useful and practical method when applied to areas of considerable size. Regardless of the relief value intervals used, major differences in local relief stand out clearly. Smaller details of the resultant patterns are ordinarily almost meaningless. The method appears best adapted to small scale maps.[6] The method has two further advantages from the standpoint of practicability. First, the work can be done rapidly. This is especially true if the relief value limits are determined in advance. A rapid inspection of each rectangle will indicate whether or not the maximum relief figure will fall near a value limit. If it does not, then it is unnecessary to determine precisely the absolute extreme values. It should be kept in mind, however, that if the relief of each rectangle is expressed only in terms of a value range it will be impossible to make more than one map from that set of data. Secondly, less reliable data will give satisfactory results. This is especially important in areas where the topographic maps are old, on small scales, and have large contour intervals.

The method of average slope depiction appears much less useful. Calculations using this method are much more time consuming. Even with practice it is not possible to count an average of more than two sheets per hour. Moreover, if the work is done steadily for more than an hour it becomes a great strain on one's vision.

If the results were highly satisfactory they might well be worth the laborious procedure necessary to obtain them. But in an area such as

[6] In many cases small local details, resulting largely from statistical accident, might best be omitted.

northern Illinois this does not appear to be true. The concept of average slope is meaningful only insofar as the majority of the slopes in an area have some approximation to the average slope. In very large sections of northern Illinois, flat interstream areas are interspersed with steep slopes along the narrow valley sides. The resultant average slope figure is nothing more than a meaningless statistical average which merely conceals the facts of actual slope conditions in such an area.

Finally, reliable topographic maps are necessary for calculations of average slope. Since reliable and detailed data are necessary for the construction of such maps, it appears to the author that if such data are available some better method of expressing slope conditions in an area can be devised. Experiments on the problem are proceeding at present.