

A METHOD OF CONSTRUCTING AVERAGE SLOPE MAPS

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The construction of an average slope map involves a major problem. If a strictly statistical method is used, terrain variations clearly visible on topographic sheets or in the field may be either suppressed or the boundaries may be distorted. If, however, terrain regions are outlined by inspection of the maps and the average slope of the regions ascertained, the problems of degree of generalization and of the treatment of transition zones immediately arise.

Construction of the sample map of northwestern Illinois (fig. 1) from topographic sheets of the U. S. Geological Survey involved the following steps.

(1) An arbitrary decision was made concerning the number of slope classifications to be used and the slope percentage indices at which breaks would occur. Because general slopes in the selected area were known to be moderate, only four such classifications were deemed necessary. The slope classes used were: Less than 1 percent, 1-5 percent, 5-9 percent, and over 9 percent.

(2) The critical percentage indices were then translated into terms utilized by Wentworth in his quantitative method of determining average slope.¹ Thus it was found that on a standard topographic sheet with a contour interval of 20 feet, any area wherein there were 1.7 or fewer contour intersections per aver-

age mile along a random line had an average slope of less than 1 percent. Areas characterized by averages of 1.7-8.4, 8.4-15.2, and over 15.2 intersections were placed respectively in the 1-5 percent, 5-9 percent, and over 9 percent classifications. This eliminated the necessity of using the average slope equation for ascertaining average slope in each area.

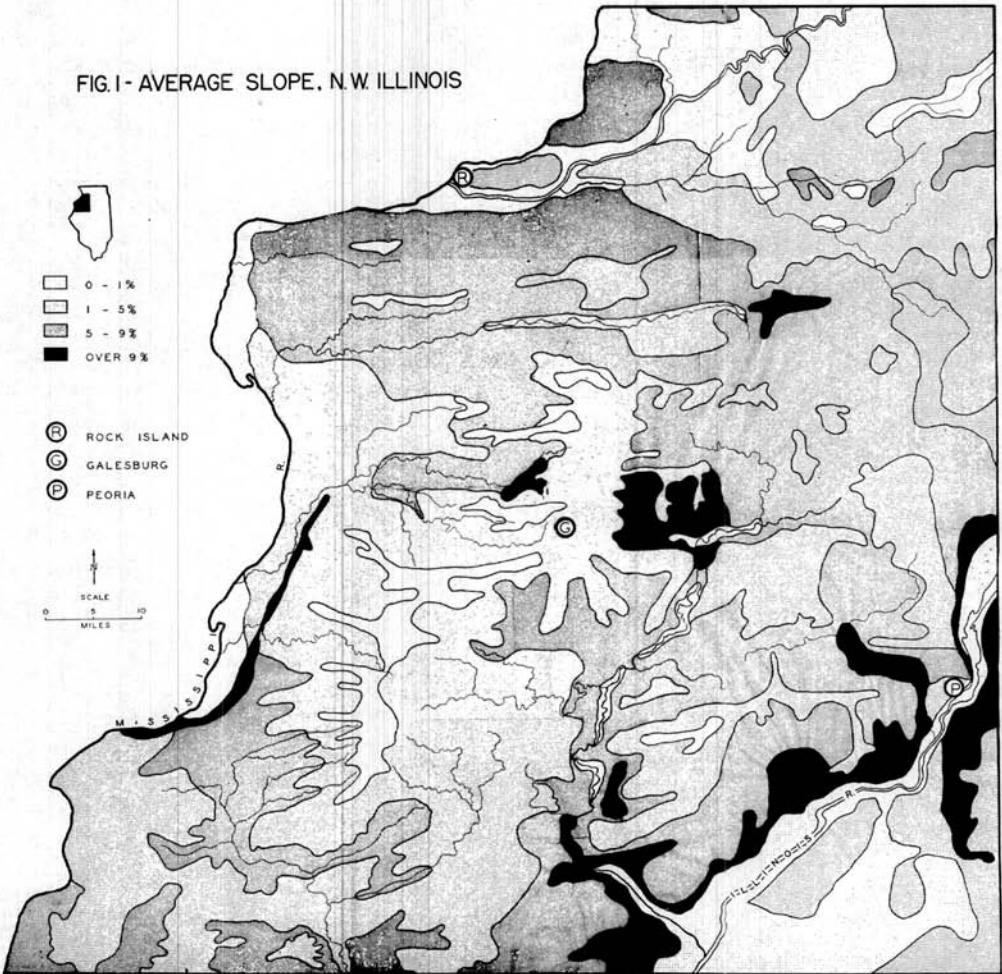
(3) Boundaries were then drawn between areas which, from inspection of topographic sheets, were believed to have significantly different terrain characteristics. This method has been used previously by Raisz and Henry.²

The resulting map portrays slope conditions in the general manner in which they are found in reality. The most pronounced and continuous appearance of highest slopes is in the Peoria section where the Illinois River traverses the Bloomington moraine. Minor expressions of such slopes are found in Illinoian drift along the Mississippi and Spoon rivers. Transitional areas of moderate slope tend to be in juxtaposition to steepest slopes and also to coincide with drainage basins of auxiliary streams wherever moraine and other deposits are not sharply dissected. Extensive areas of very flat land are generally interfluves separating minor tributaries or smaller strips characterizing flood plains.

¹ Wentworth, C. K., A simplified method of determining average slope of land surfaces: *American Journal of Science*, ser. 5, vol. 20, 1930, pp. 184-194.

² Raisz, Erwin, and Joyce Henry, An average slope map of southern New England: *Geog. Rev.*, vol. 27, 1937, pp. 467-472.

FIG. 1- AVERAGE SLOPE, N.W. ILLINOIS



This map differs markedly from one developed by an application of the Wentworth technique to the same area on a strictly statistical basis. Calef has experimented with that method in examining average slopes for 5-minute rectangles of topographic sheets.³ Results of his experiment were judged by him to be unsatisfactory, as slope conditions on

the final map were not an adequate reflection of actual conditions. For example, the map did not reveal the level flood plains of the larger rivers. This map, on the contrary, shows the extent of all large flood plains clearly and reveals that they are very flat. Calef's map suggested but delimited very poorly the areas of dissected steeply sloping lands paralleling the larger rivers. This map delimits such areas far more satisfactorily.

³ Calef, Wesley, Slope studies of northern Illinois; *Trans. Ill. Acad. Sci.*, vol. 43, 1950, pp. 110-115.

The map presented here therefore represents a radical improvement in method in the delineation of differing terrain regions. There are however, major limitations in the use of this technique, and they may be best illustrated in connection with a consideration of map scale. A major difficulty arises with the mapping of areas characterized by transitional but closely-spaced changes of slope. Such conditions are found southwest of Rockland, where a sizable area has been classified as containing slopes of 5-9 percent. Here the drainage texture is rather closely woven, so that frequent changes appear in the degree of slope. A few flat upland surfaces are sufficiently large and distinct that they can be delimited, but on the whole the 5-9 percent classification represents a rather broad generalization of slope conditions, with more refinement impossible because of the nature of the terrain. An increase in map scale would be of little value, because the areas of transition between slope classifications would tend to be larger than areas falling definitely within one slope classification.

A second difficulty arises in indicating the edges of dissected uplands. The large area of very flat land southwest of Galesburg, designated as 1-5 percent in slope, may be taken as an example. Here the smooth upland surface fuses almost imperceptibly into the gentle slopes of the upper stream valleys. In delimiting the area, therefore, rather pronounced subjectivity must be exercised. An increase in map scale would serve only to magnify the extent of this transition and would not solve the problem.

A third limitation to this method is that of subjectivity. Two workers employing the same set of criteria on a common area will not produce similar results. This differential becomes more pronounced when the terrain is uniform, as the element of subjectivity must be exercised to a greater extent in delimiting such an area.

The position of boundary lines and therefore the general orientation of the finished map depend upon the number and scope of slope classifications which have been subjectively established. Some areas have slopes near the upper or lower limit of a given slope classification. Use of a slope classification system based upon different percentage indices would, of course, alter the size and number of individual delimited areas on the finished map. Nothing substantially would be gained by using the new criteria, however, as there would still be slopes which would just fall within a classification, and the general orientation of the finished map would not differ markedly from that shown here.

In summary, where terrain conditions are quite uniform, the proposed method of representing average slope is unsatisfactory because of excessive generalization of terrain conditions and because the delimiting process is highly subjective. Changing the map scale or the number of slope classifications will not effectively improve the quality of the method in this respect. Where there are sharp breaks between two wholly different areas of terrain, the proposed method is superior in that such divisions can be precisely located on the final map.