Feasibility of Automated Derivation of Watersheds

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INTRODUCTION AND PROBLEM DEFINITION

The review of water appropriation and use permit applications, by Maryland Water Resources Administration personnel, often requires an estimation of the flows of ungaged stream reaches. Flow characteristics are estimated by an area-proportional correlation with gaged watersheds of similar character. At present, the drainage area contributing to a withdrawal point under consideration is calculated manually. First, the point is located on a topographic map and (based on contour lines and stream channels) the drainage area boundary is sketched. The area of contributing drainage is then determined by planimeter. Finally, an area-proportional correlation is made with a selected gaged watershed, and flow characteristics are determined as a function of flow per square mile of contributing area. Another (rather rougher) method with potential application is the development of flow characteristics as a function of flow per linear mile of contributing stream.

ICPRB has searched the literature, and pursued leads at university, governmental and private institutions working on the issue of automated drainage area calculations. The feasibility of automatically determining drainage area has been explored and the findings are presented in this short report.

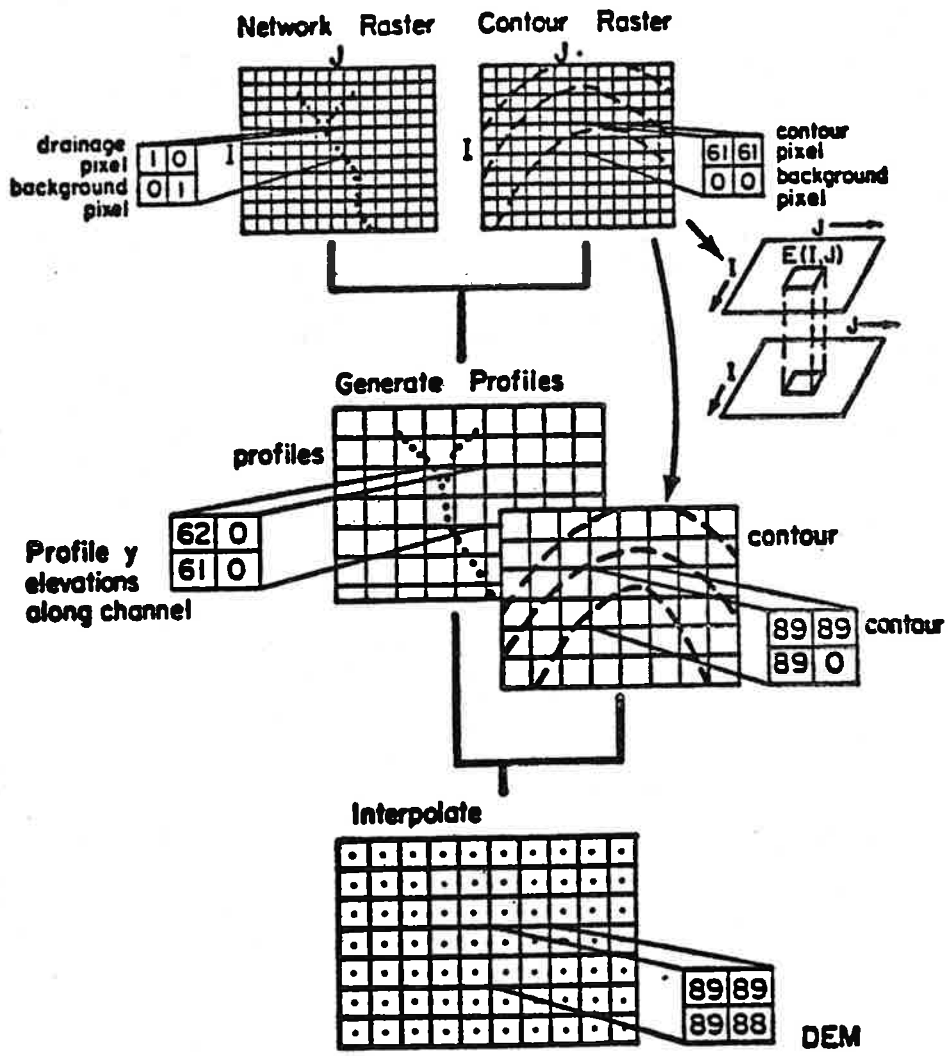
DATA REQUIREMENTS

Any automated map work appears to require relatively large digital data sets. The primary data sets which would be required for computerized drainage area determination include stream channel delineations and topographic contours. A secondary data set might be an elevation grid or raster, referred to as a digital elevation model. Elevation for most of the United States is available at a coarse grid scale from 1:250,000 maps. As of January 1, 1987, parts of western Maryland and Montgomery County elevations were digitized at a grid spacing of 30 meters from 1:24,000 maps. As the degree of resolution or detail increases in the data set so does its size, cost of acquisition, storage, and use. However, more detail in the data implies greater accuracy in the results of their use. Fellows and Ragan (1986) have conducted sensitivity analyses with regard to grid size in the application of an algorithm which automatically generates watershed drainage areas. Their conclusion is that shape of hydrograph is more affected by changes in grid size than quantity of runoff, and that the effect is reduced as the size of basin increases.

Minor factors other than drainage area which characterize runoff from a basin include: land use, degree of imperviousness, ground cover, elevation, slope, aspect, and transmissivity of underlying geology. Present conditions and likely future changes in land use might deserve consideration in the characterization of runoff from ungaged watersheds. Contemporary runoff modeling often includes parameters other than area.

COMPUTATIONAL ALGORITHMIC APPROACH

The steps required to convert cartographic information into delineated drainage basins and the computation of their areas manually are described in the Introduction. Automated algorithms do exist in some forms (Band, 1985; Flewelling, 1984; Jenson, 1985; Marks, 1984; Sircar, 1986). The algorithm, or programming, to determine drainage basin boundary may proceed in one of two ways. (1) proceed directly from the known channel point of interest, and digitized contour line and stream channel information. (2) more likely, from digitized contour line and stream channel information develop a digital elevation model of the general area of interest, then proceed from the known channel point of interest to develop the basin boundary. The input and output for developing a digital elevation model are shown well in Figure IV-5 from Sircar, reproduced here to save at least a thousand words. A search and labeling computer algorithm would have to be obtained or written to select the grid points which define the basin boundary; and another to calculate the basin area. A plotter program to display the boundary for verification by comparison with topographic maps would be a useful supplement to the other software requirements.



(From Sircar, 1986)

FIGURE IV-5. A Schematic Showing the Basic Input/Output Information Flow to Create a DEM Using the Proposed Approach

CONCLUSIONS

The primary conclusion from this investigation is that automated drainage basin boundary and area determination is feasible.

Governmental, educational and private consulting entities are pursuing automated transformation of the required cartographic information into digital representation. Maryland topography, with its lack of significant sink holes, "lost rivers" and internal drainage basins, is a good candidate for straight-forward basin boundary delineation. Computerized algorithms already exist or could be written which would calculate basin area and plot derived boundaries.

During the course of this investigation, other agencies in the Potomac River Basin indicated an interest in the project with possible applications of their own if useful products could be developed. Many of the technical resource and reference contacts (Jenson, USGS; Mundorff, TENTIME; Gregory, WET; Ragan, UofM) indicated a willingness to prepare a proposal to develop products for automated basin boundary and area derivation. If there is continuing interest by Maryland Department of Natural Resources in this subject, ICPRB could determine the level of interest and financial support from other Potomac Basin agencies and proceed with the development of a request for proposals.

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