GEOLOGICAL INFORMATION
IN A COMPUTER MAPPING SYSTEM FOR LAND USE PLANNING

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INTRODUCTION

The U.S. Geological Survey (U.S.G.S.) is investigating methods for communicating relevant geologic information to land-use planners and decision makers. If geologic information is to be used effectively in the planning process, it must be understood by planners so that it can be combined with other planning factors. Several special mapping projects of the U.S.G.S. have been successful in transmitting technical planning related geologic information to nongeologists. This paper describes a geographic information system which permits a planner to combine different types of mapped information.

SYSTEM DESIGN

In order to be of maximum use in a planning office, a geographic information system should combine map overlay capability, scale flexibility, speed, and ease of operation. The traditional method of hand-drawn transparent overlays is easy to use, but is costly and time consuming, and limits the number of maps that can be practically combined. The computer-aided system which was chosen to satisfy the requirements for this pilot study uses cell format, line printer maps, and manual digitizing. The Multi-Scale Data Analysis and Mapping Program (MSDAMP) was developed at the Land Use Analysis Laboratory of Iowa State University. The cell format was selected for input, storage, and output, because it provided the most understandable and inexpensive way to overlay, or composite maps with the computer. Output maps are produced on a line printer because it is the most universally available output device and is consistent with the cell format. Manual digitizing has a high degree of accuracy, can be done in the planning office by clerks, and does not require any equipment acquisition.

DIGITIZING

The process of converting to machine readable form is called digitizing. For this information system the digitizing is usually done by a team of two people, one reading the map and the other one recording. A regular sampling grid with a dot at the center of each cell is superimposed on the source map to be digitized, and the latitude-longitude address and map unit code for the mapped unit are recorded for each cell. To speed up the process, only the first cell of a repeating unit (scanning from left to right) must be recorded, and the rest are accounted for by recording the number of repeat cells. Digitizing speeds range from 300 to 1,500 cells per hour, depending on cell size and map complexity.

COMPUTER COMPOSITE MAPPING

Once the factor maps are digitized, information from the different maps can be composited by the computer on a cell-by-cell basis. Figure 1 illustrates how three factors can be composited. In this example a planner wants to locate a development so that it avoids shallow bedrock, trees, and surface water. The top row depicts the source map divided into cells and the second row shows diagrammatically how the digitized maps look to the computer. In the next step, the planner assigns numbers

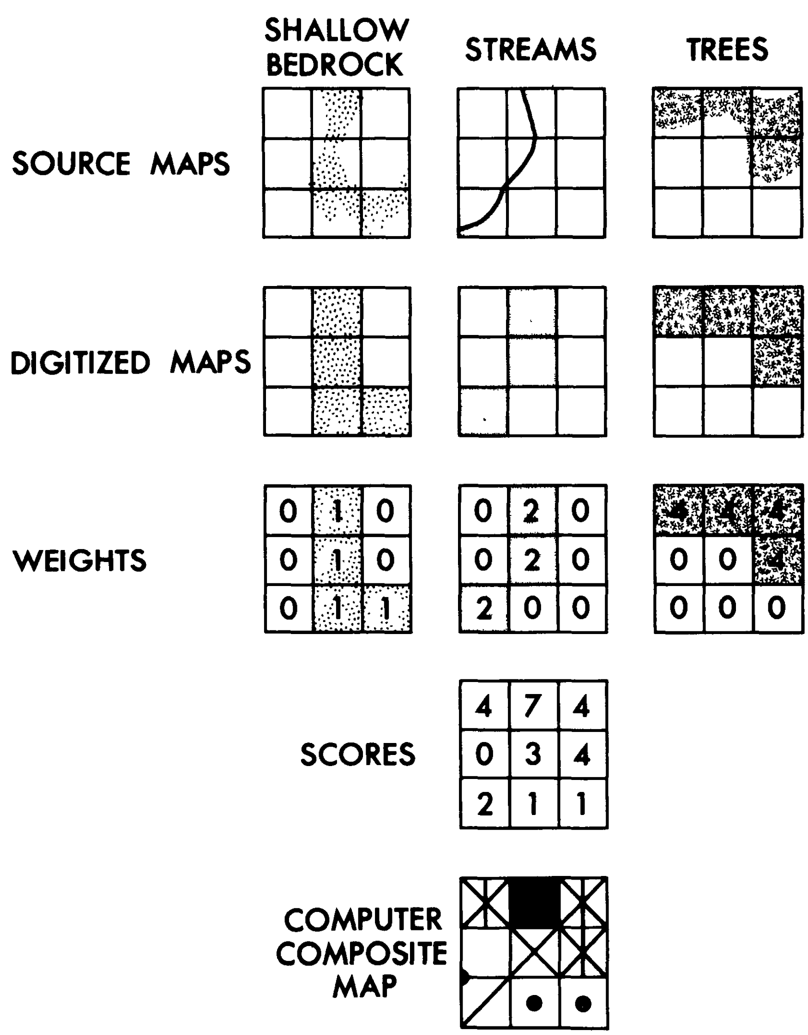

Figure 1: Example of compositing

or values (weights) to the presence or absence of the factors. The computer takes the numbers recorded for each cell and adds them to produce a score. Finally the composite map is produced on a line printer with the symbol the user has assigned to each score level. In this example, light cells indicate more desirable areas for development and dark cells are less desirable.

The computer program permits the use of any integer numbers for factor values so that each combination of the factors can have a unique score. In this example using values 1, 2, and 4 produces scores from 0 through 7, and each score represents a particular combination of factors. This capability to separate the factors on a composite map can also be used to assign different weights to the factors. For this analysis the planner has judged that the presence of trees is 4 times as important as the presence of shallow bedrock and twice as important as the presence of surface water. Another planner might weight these factors differently and derive a substantially different composit map. This weighting capability is a useful feature in a decision-making process because it provides a means of visually displaying different opinions and permits more logical discussion of opposing viewpoints.

APPLICATION OF THE SYSTEM

Montgomery County, Maryland, located just north of Washington, D.C., was selected as a test site for the information system because of the interest expressed by environmental planners in the county and because of the availability of recently published, planning-oriented geologic information.

The Montgomery County Folio, published at 1:62,500 scale, includes topography, surface water, bedrock, surface materials, bedrock contour, and overburden thickness. All of these maps, except overburden thickness, have been digitized. Additional factors, including vegetation, slope, and land use, have been digitized for a small portion of the county.

Planners in the Environmental Planning Division of the Maryland-National Capital Parks and Planning Commission (MNCPPC) have used the information system to examine an area in which urban growth will be stimulated by new and improved transportation facilities. The Shady Grove Planning Sector is an area of about 20 square miles (52 km^2) which will be affected by the construction of a terminal station for the Washington Rapid Transit system (METRO) within the next five years. Natural conditions which would affect future urban development were analyzed with a view toward directing this growth to minimize damage to the environment and avoiding unnecessary construction problems.

The factors chosen were: presence of steep slopes (15%), shallow bedrock, alluvium, surface water, and mature trees. Presence of the first three factors on a site would increase construction costs. Mature trees and surface water are resources the people of the county wish to preserve. These five factors were composited by the computer to produce a map showing natural conditions affecting urbanization (Figure 2). The blank areas on this map are those in which none of the five factors occurs, and darker shades of gray indicate various combinations of two, three, four, or five of the factors. In order to remove areas already developed, all the various types of land use were collectively called developed and committed land, and combined with the natural factors to produce the final composite (Figure 3). The darkest symbol on this map indicates presently developed land not warranting further environmental consideration; undeveloped areas with no natural limitations are shown in white, and undeveloped areas with various combinations of natural

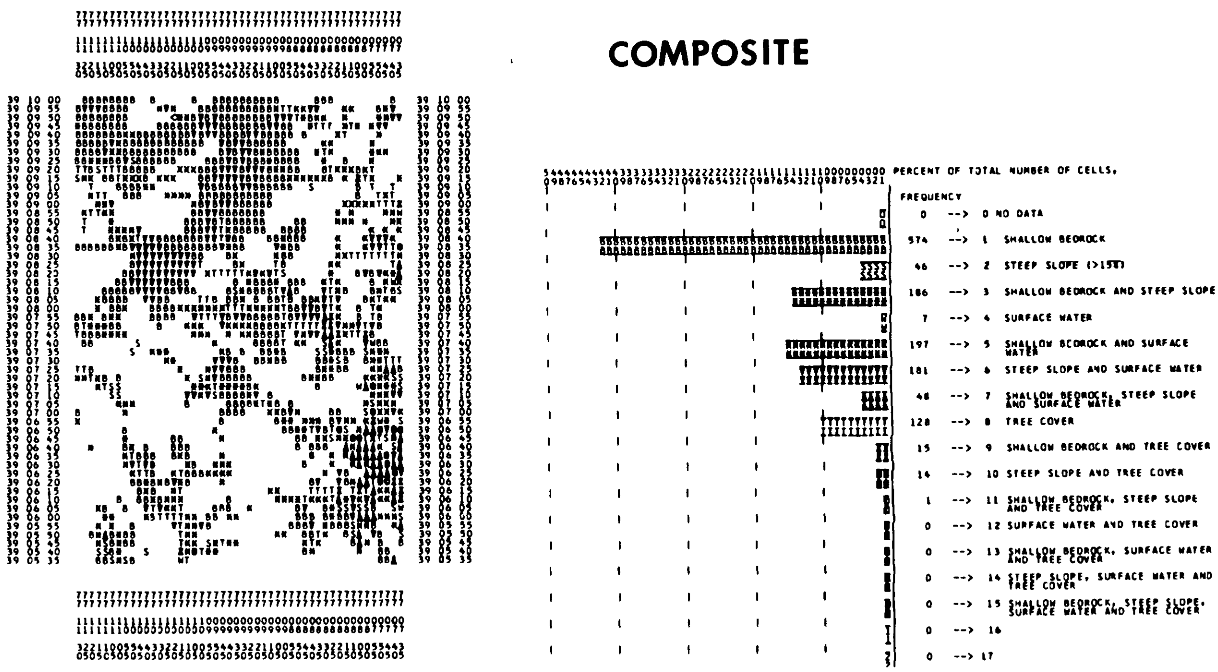

Figure 2: Composite computer map of Shady Grove area, Montgomery County, Maryland

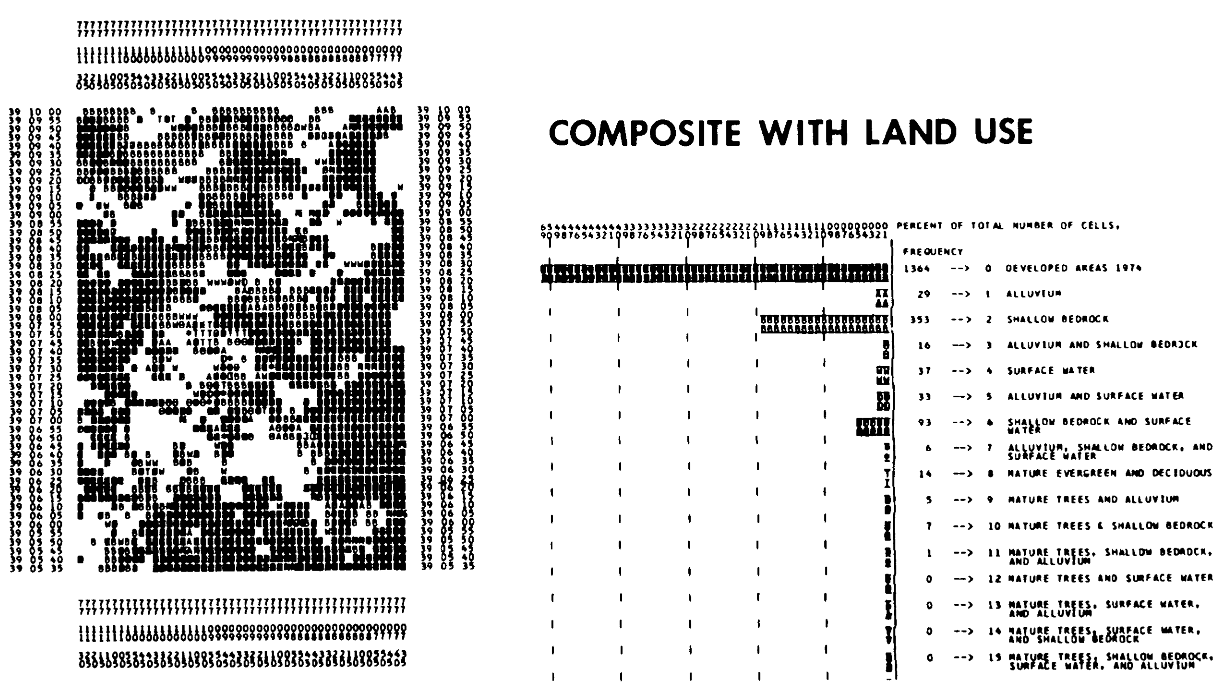

Figure 3: Composite computer map of Shady Grove sector, Montgomery County, Maryland

factors are depicted in shades of gray. A transparent overlay showing the current master development plan for this area was superimposed on the computer composite map and several areas of conflict were apparent. These conflicts, where environmental damage would result from the proposed development, were resolved by using the computer composite map to revise the master plan for the Shady Grove sector.

The environmental planners in Montgomery County have used the computer information system to locate a sanitary landfill. This type of site selection is a process of elimination of undesirable areas on a reconnaissance level, followed by detailed investigation of favorable sites. For initial reconnaissance, the undesirable characteristics composited were the presence of surface water, shallow bedrock, and poorly or excessively drained surface materials. The composite map (Figure 4) shows in dark symbols combinations of one, two, or three of the undesirable features. The white areas on the map have 20 feet or more of well drained surface material with no surface water present. These favorable areas were further screened with factors such as land ownership, population density, and transportation routes.

In summary, the application of this geographic information system in the Maryland-National Capital Parks and Planning Commission's Environmental Planning Division has provided the planners with a readily accessible source of objective, planning-related, earth science facts, and an inexpensive, rapid and flexible tool for combining these facts with various biases to produce decision alternatives.

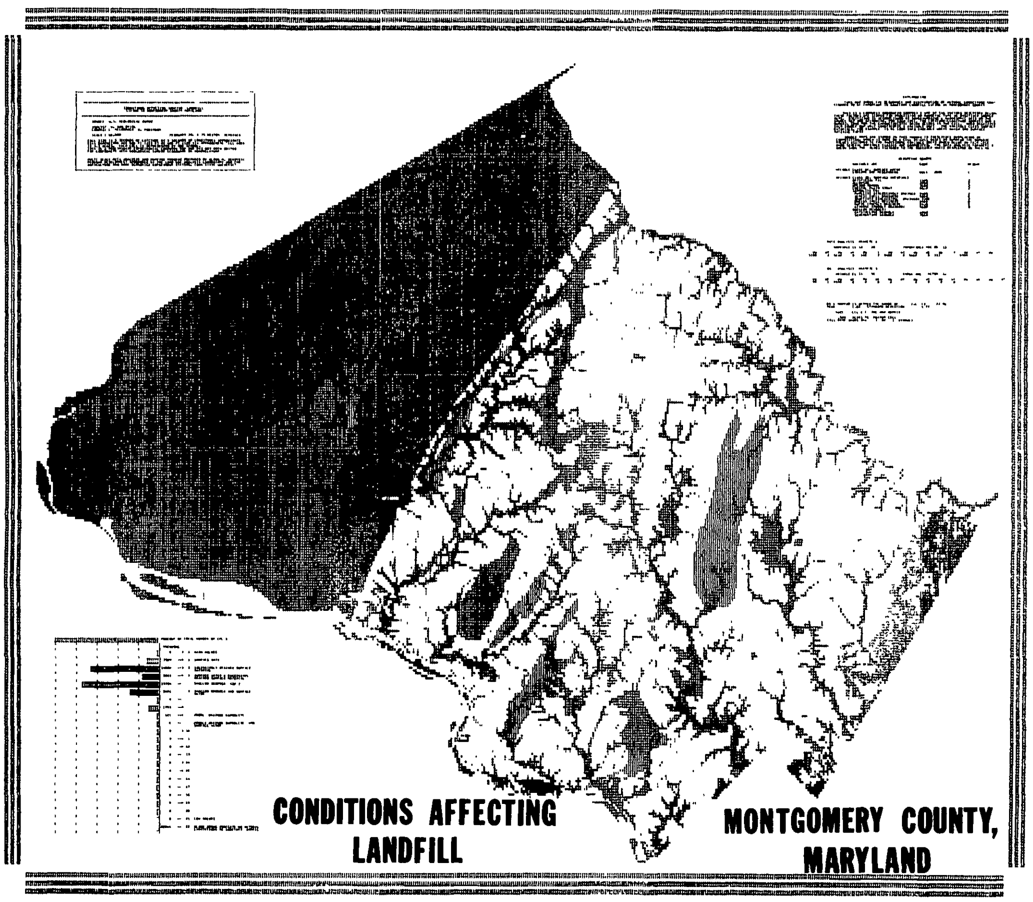

Figure 4: Composite computer map of Montgomery County, Maryland showing conditions affecting landfill