# JOINT STATE/REGIONAL ENVIRONMENTAL PLANNING USING THE PEMSO/ADAPT GEOGRAPHIC INFORMATION SYSTEM

Walter M. Grayman
W.E. Gates and Associates, Inc.
Batavia, Ohio 45103
and
Barbara A. Wooldridge
Ohio Environmental Protection Agency
Columbus, Ohio 43216
and
E.B. Long and Andrew C. Vidra
Northeast Ohio Areawide Coordinating Agency
Cleveland, Ohio 44115

## Introduction

Computerized geographic information systems (GIS) are systems for handling spatially arranged data bases. They are usually developed and used within a single institutional framework. Although a multi-agency application can result in time and cost savings and provide a common ground for evaluation, such joint use of GIS technology is rare. A successful multi-agency application requires a positive institutional structure and a systems technology capable of responding to the various needs of the agencies involved. This paper describes the application of a geographic information system in a multi-agency context.

The Planning and Engineering Data Management System for Ohio (PEMSO) was developed for the Ohio Environmental Protection Agency by W.E. Gates and Associates based upon their Areal Design and Planning Tool (ADAPT). This system was originally designed for environmental planning at the state level. The Northeast Ohio Areawide Coordinating Agency (NOACA) under a grant from

U.S. EPA was to develop a methodology/approach for urban stormwater problem assessment. It was determined that the approach to be developed should have applicability statewide, and should result in a planning tool usable at the state and local level. Thus NOACA and the Ohio EPA entered into an agreement to utilize and refine PEMSO/ ADAPT, for this project. Through the services of W.E. Gates and Associates, the State developed the PEMSO/ADAPT analytic capabilities for their portion of the project. The joint urban stormwater project was its first application at sub-state/local levels. The specific study objective were both the aforementioned methodology development (state level) and the characterization/selection of hydrologic areas for a future intensive sampling and analysis program aimed at urban stormwater problems in the NOACA region. The study used a hierarchical planning approach: a screening procedure which employed the PEMSO/ ADAPT data base to identify representative hydrologic areas and a detailed analysis which employed a higher resolution data base for each of the identified hydrologic areas. The ease, speed, and low cost associated with the development of the PEMSO/ADAPT data base for Ohio made this approach possible.

## The ADAPT System

The ADAPT technology on which the PEMSO system is based (Ref. 2 - 6) is oriented towards analytical modeling and representation of terrain and networks. It features a variable-resolution, triangular grid cell as the primary data storage mechanism, providing significant efficiency and a true three-dimensional data base. Terrain is represented by the triangular faceted surface as shown in Figure 1. Triangle sides and vertices are selected as lines and points of 'high information content', representing streams, ridges, slope breaks, peaks., etc. Triangle sides also represent other boundaries such as soil associations, political jurisdictions, etc. In addition, an overland flow and stream network is generated based on the stored digital terrain model. Thus, a simple, comprehensive and powerful method of manipulating terrain, coverage, and network data in a unified fashion is made possible.

## Screening Process

The initial project effort used the PEMSO/ADAPT data base to 'screen' the study area to select sub-basins for

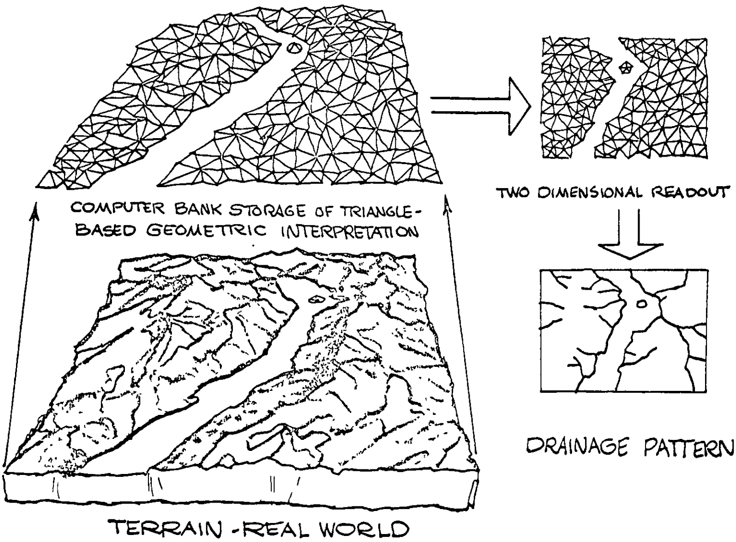


Figure 1 Terrain Representation in ADAPT (drawing by Robert Tourt, OEPA)

further study. In the NOACA area, covering approximately 3000 square miles, the data base is composed of a grid of approximately 50,000 triangles (Figure 2) providing a continuous digital terrain model, soils, land use, population density, political boundary information, and a representation of the overland flow/stream drainage network (Figure 3). The screening process provided information on both the land character and the impacts of land development on the stream. Shaded plots were prepared using a pen plotter to display information on non-point source pollution generation rates, population density in sewered and unsewered areas, runoff potential, and other factors pertinent to basin selection. A typical plot of sediment erosion in Lake County, estimated by the Universal Soil Loss Equation, is presented in Figure 4. Predicted stream impacts were displayed in stream profiles generated from the data base and drawn in multiple colors on a pen plotter for the 80 major streams in the area. These profiles display variables such as upstream population, drainage area, non-point source loads, and streamflow along a stream. A set of profiles for Plum Creek is presented in Figure 5.

Based on the information provided by the shaded plots,

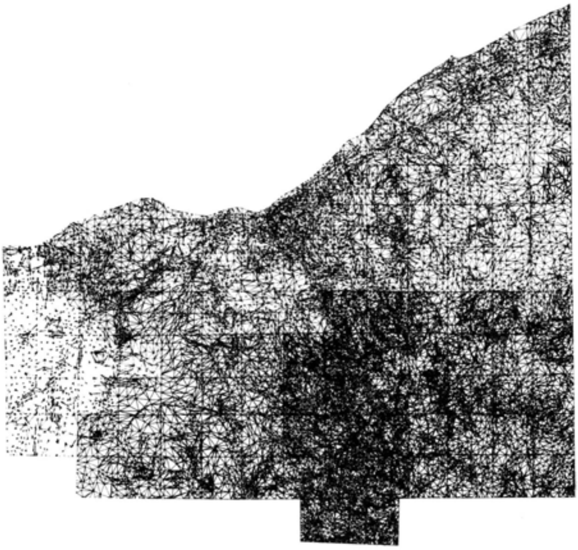

Figure 2 Triangular Grid Representation of NOACA Area

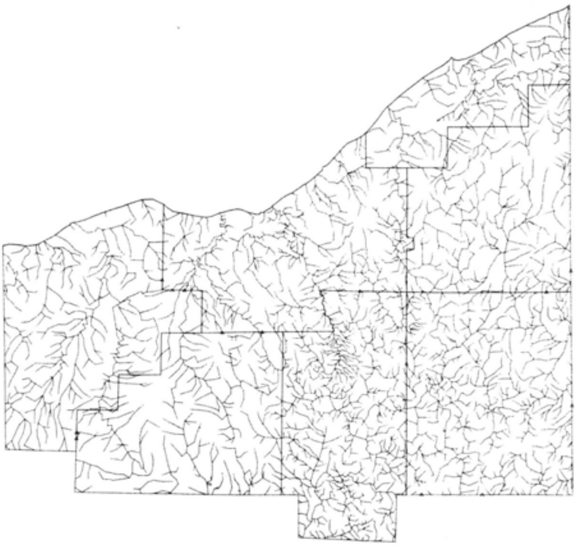

Figure 3 Stream Network in NOACA Area

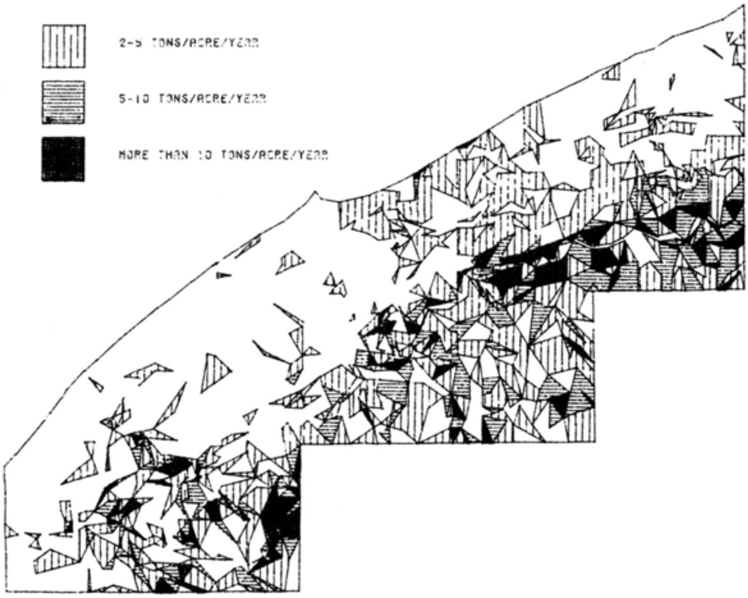


Figure 4 Shaded Plot: Sediment Erosion, Lake Co.

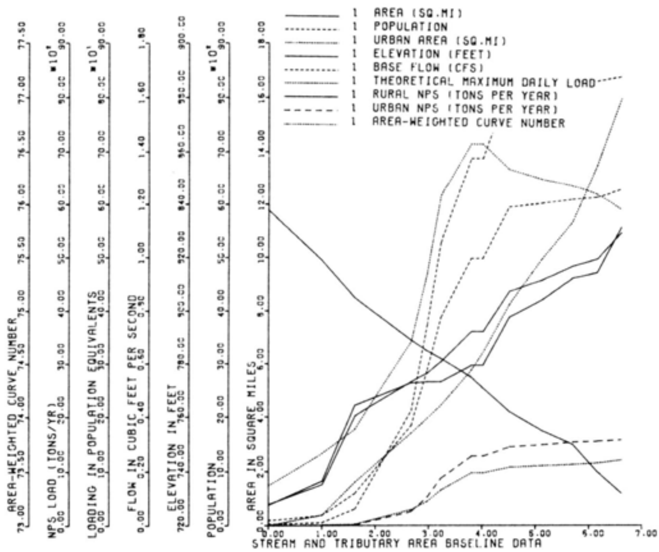


Figure 5 Stream Profiles: Plum Creek at Oberlin,Ohio

the stream profiles, NOACA area biological, geographic and drainage data (and with consideration given to the development of generalized methodology) 12 representative basins with a total area of approximately 100 square miles were selected for detailed study.

## Detailed Analysis

The detailed analysis of critical problem areas identified during the screening process involves the use of more complex models using information at a finer spatial scale than that provided in the generalized statewide data base. The low cost and ease of establishment of a data base made it feasible to create a detailed data base that was approximately five times higher in resolution than the generalized statewide data base (average grid size: 10 acres vs. 50 acres), as shown in Figure 6.

A hydrologic and non-point source analysis for each of the basins under selected intense storm events was carried out using a model which computes runoff and pollutant generation/pickup for each grid and routes it through the overland flow/stream network (Figure 7), yielding hydrographs (Figure 8) and pollutographs (time histories of flow and pollutant concentration) for each basin. Based upon these analyses, several of the basins were selected for a future intensive field sampling program aimed at identifying the effects of urban drainage on the stream environment.

## Conclusion

The study illustrated the value of a geographic information system in a real life multi-agency study. The statewide application of the generalized data base was found to be instrumental in identifying and analyzing localized urban stormwater critical problems. Area-specific expertise was then supplied by the local planning agency to analyze in detail the identified critical problem areas. Much of the success of the multiple agency process was due to specific characteristics of the PEMSO/ADAPT system. These characteristics include: the interface capacity with complex engineering and planning models; the representation of both land-based characteristics and stream networks; the variable resolution capability; the ability to use alternative resolution grids; and the versatile display techniques. The use of the PEMSO/ADAPT system by both

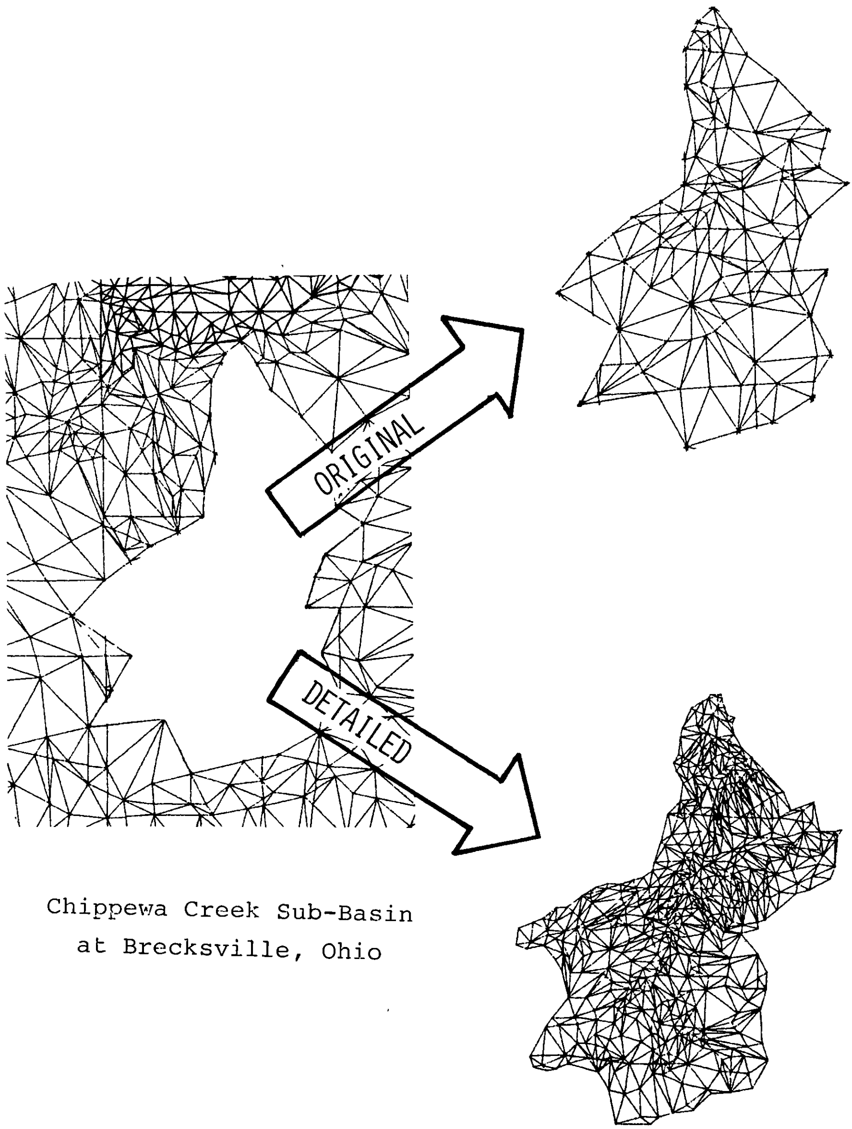


Figure 6 Use of Variable Resolution for Detailed Local Planning

State and local agencies provided a common ground of evaluation and facilitated inter-agency communication regarding recommended control programs.

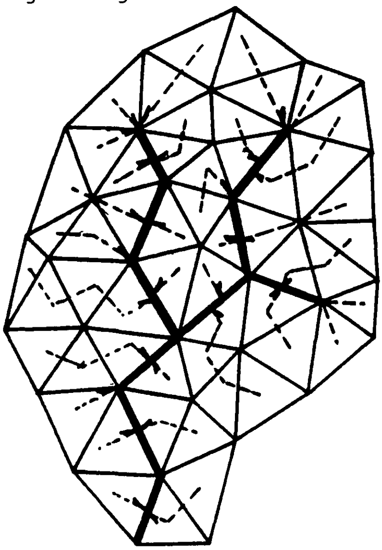

Figure 7: Example Drainage Network

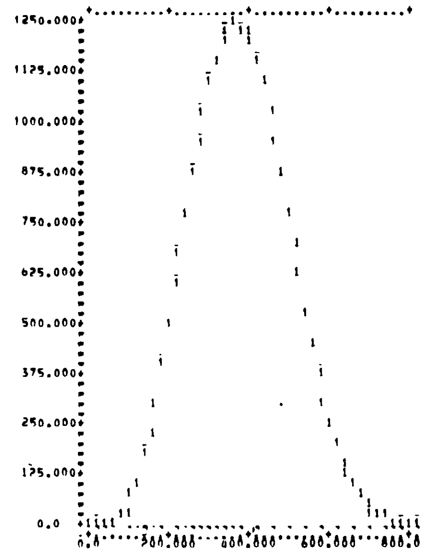


Figure 8: Hydrograph from Rainfall-Runoff Model, Cahoon Cr.

<u>References</u>

1. "Urban Stormwater Investigation", Final Report, NOACA, Cleveland, Ohio, 1979
2. "ADAPT: A Digital-Terrain Model Based Geographic Information System", Symposium, Lab. for Computer Graphics and Spat. Analysis, Harvard Univ., July 1979
3. "Computer-Assisted Land Resources Planning:, Schneider, D., Amanullah, S., Planning Adv. Serv. Report 339, APA, Chicago, Illinois, January 1979
4. "The Digital Terrain Model: A Tool for Quantifying Terrain Characteristics", Heil, R., Brych, S., Proc. ACSM Conf., Albuquerque, N.M., October 1978
5. "ADAPT Sewer Design Geographic Information System", Grayman, W., Koch, P., Proc. Conf. on Computing in Civil Engineering, ASCE, New York, June 1978
6. PEMSO User's Manual, Ohio EPA (Columbus, Ohio), 1979, in preparation