WATER QUALITY ASSESSMENT OF THE SUWANNEE RIVER BASIN

Jean-Paul Calixte[1] and Jimmy R. Bramblett[2]

AUTHORS: [1]Water Resources Planning Specialist, United Stated Department of Agriculture, Natural Resources Conservation Service, Gainesville, Florida 32614; and [2]Resource Conservationist, United States Department of Agriculture, Natural Resources Conservation Service, Athens Georgia 30601.
REFERENCE: Proceedings of the 1997 Georgia Water Resources Conference, held March 20-22, 1997, at The University of Georgia, Kathryn J. Hatcher, Editor, Institute of Ecology, The University of Georgia, Athens, Georgia.

Abstract. The Suwannee River Basin has been the focus of an interstate Cooperative River Basin Study [CRBS] for the past two years. Federal, state, and local agencies along with a number of private organizations have identified and prioritized natural resource concerns, including the impact of nonpoint source pollution on water quality. Many of these concerns have been documented in a number of water quality reports published for each of the Suwannee River's six subbasins. The Natural Resources Conservation Service used a Pollution Load Screening Model [PLSM], during the CRBS, to estimate the annual loading of pollutants based on potential runoff characteristics derived from different types of land use, soil hydrologic groups, and rainfall distribution. Integrated with a Geographic Information System [GIS], the PLSM facilitated prioritization of watersheds in the Suwannee River Basin based on relative pollution potentials. A menu-driven user interface has also been developed to allow natural resource planners to review and analyze results from the PLSM as well as display maps of existing land and water features in the basin. Content of water quality reports, implementation of the PLSM, results of the PLSM, and PLSM practical applications are discussed. This model-based GIS application demonstrates the effectiveness of modern technologies in evaluating nonpoint source pollution data at a basin scale. It can be used by decision makers as a planning tool to better focus future efforts in the management of natural resources.

INTRODUCTION

The Suwannee River Basin [Basin] consists of approximately 11,020 square miles and is almost equally divided between Georgia and Florida. Although Stephen Foster may have never seen the Suwannee River, he accurately portrayed it in song as a placid stream coursing an area of pleasant and satisfying living. Streams of the Basin and their environments are just as beautiful today as they were 150 years ago (U.S. Study Commission, 1963).

Recognizing the Basin's natural amenities, the Suwannee River Water Management District [District] in Live Oak, Florida initiated a coordinated interstate assessment of the Basin in 1993. The Natural Resources Conservation Service [NRCS] agreed to assist the District with identifying local natural resource concerns in both Georgia and Florida. During a public participation process, numerous individuals and agencies expressed great concern for protecting relatively unspoiled environments of the Basin. All of the Soil and Water Conservation Districts and Resource Conservation and Development Councils within the Basin joined the District as formal Sponsors of a two year CRBS spearheaded by NRCS. A Steering Committee was established to guide efforts of the CRBS and over seventy individuals participated as a member of this Committee.

The CRBS had five major objectives: water quality assessment, water quantity projections, economic development projections, environmental assessment, and interstate/interagency coordination. This paper will focus on the CRBS's water quality assessment, which assessed potential impacts to the Basin's surface waters via nonpoint source pollution..

BACKGROUND

The Federal Clean Water Act of 1987 requires states to assess the status of their water bodies. Some of these assessments are reported in Section 319 and 305[b] reports for each State. Theses reports, and other water quality studies, support the local concerns for protecting and maintaining a relatively unspoiled nature within the Basin. Several river segments no longer support, or only partially support, their designated uses (Georgia EPD, 1994); or have a threatened impairment status (Florida DER, 1989). The latter rating implies that the designated use is not being impaired by nonpoint source pollution, but acknowledges an existing, or potential, downward trend in the water quality of a suspected water body. Without additional management, the designated use will be impaired within five years.

Point source pollution is regularly monitored within the Basin. Currently there are no fines for point source discharges violations. Three municipalities - Valdosta, Ga; Tifton, Ga; Lake City, Fl - and one mining operation - Hamilton County, Fl - require significant attention to point source discharges. Nonpoint source pollution, on the other hand, represent the greatest single threat to preserving good water quality in the Suwannee River, its tributaries, and its estuary (Matson and Rowan, 1989).

RELATED RESEARCH

In order to efficiently address nonpoint source pollution concerns in the Basin, it becomes necessary to prioritize the most critical land units for accelerated treatment by future water quality projects. Previous studies in watershed prioritization have used a wide variety of methods to accomplish this task.

An assessment of nonpoint source pollution in Long Island Sound, NY considered proximity of watersheds to the Sound, percentage of agricultural and urban land use giving higher delivery ratio's to urban land, and particularly those urban lands in close proximity to the Sound itself (Frink et al., 1993). The NRCS in Georgia utilized a prioritization scheme that focused on agricultural nonpoint source pollution by determining animal units, crop acreage, and runoff potential to relatively rank subwatersheds in the State (USDA SCS, 1993). In Washington, the Colville River Basin's subwatersheds were ranked by an eighteen member committee which looked at current threats to beneficial uses, the likelihood of intensified land use, environmental factors that increase the probability of water quality degradation, and a comparison of contaminants across watershed boundaries (Kessler and Dugan, 1993). The Environmental Resources Research Institute of Penn State University ranked the Chesapeake Bay's 104 watersheds based on an Agricultural Pollution Potential Index which is a composite of four separate indices developed for runoff, chemical usage, sediment production, and animal loadings (Peterson et al., 1991; Kasi, 1993). The Northwest Florida Water Management District [NWFWMD] looked at urban and rural nonpoint source pollution to the Appalachicola River and Bay by focusing on four water quality parameters: total nitrogen, total phosphorus, total suspended solids, and biological oxygen demand. These water quality parameters were used in conjunction with runoff concentrations for various land usage to developed a cumulative ranking index which represents an overall measure of potential nonpoint source pollution (Raines and Lathem, 1993). The St. Johns Water Management District, also in Florida, utilized the same process as the NWFWMD, but included lead and zinc, projected future land use, and ranked watersheds by percentiles for each nutrient individually, rather than through a cumulative ranking index (Adamus and Bergman, 1993).

METHODS

The PLSM utilized in this study is a composite of the many nonpoint source pollution screening methods previously employed. This model estimates annual loadings of pollutants based on potential runoff characteristics derived from different types of land use, soil hydrologic groups, and rainfall patterns (See Figure 1). Rainfall generates a certain amount of surface runoff which varies according to the imperviousness of a particular type of land use and the infiltration/runoff characteristics of a soil mapping unit. The estimated volume of surface runoff has the capacity to transport pollutants released from different land use types.Loadings from animal operations were accounted for separately because there was no land use category in the available land use map. Potential loadings were calculated for four pollutants TN, TP, TSS, and BOD. These loadings were accumulated for each subwatershed. An average loading per acre was calculated and used as the basis for ranking each subwatershed by each pollutant category. A cumulative ranking index was then calculated by averaging the four rankings of each subwatershed. The CRI was used as an overall nonpoint source pollution index to compare potential pollution across subwatersheds of the Basin.

DATA UTILIZED

A total of seven spatial and nonspatial layers were compiled in a GIS for the nonpoint source pollution potential assessment. Watershed boundaries from NRCS and USGS hydrologic unit delineations in each State served as the base layer from which to build other data layers. The land use layer was developed by ERDAS, Inc using 1988-90 LANDSAT imagery. The State Soil Geographic data base [STASGO] was utilized for soil hydrologic group information. Long term rainfall average values were obtained from the Southeast Regional Climate Center of the National Oceanic and Atmospheric Administration and the SRWMD. Runoff coefficients were used to estimate the

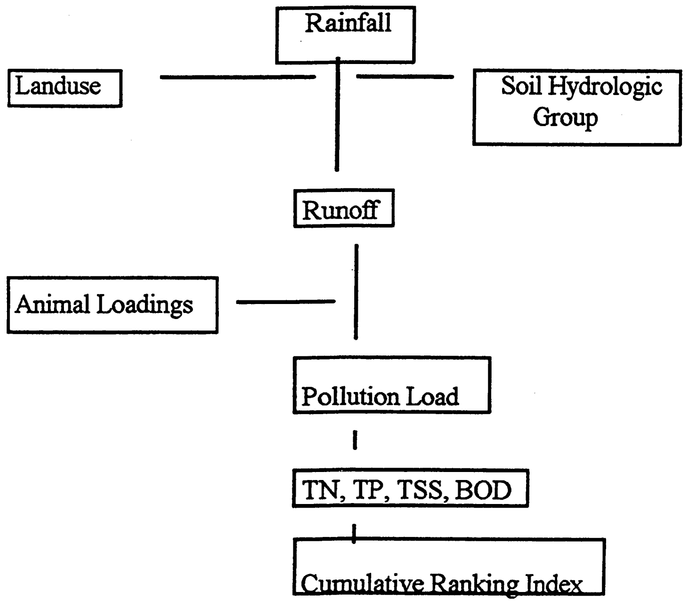

Figure 1. Parameters included in the Pollution Load Screening Model.

portion of rainfall which becomes runoff for each land use category and soil hydrologic group, and were developedfrom the following formula:

C = LLC + (ULC - LLC) * H, where

C = runoff coefficient for a given land use/soil combination
LLC = lower limit runoff coefficient for a given land use/soil combination
ULC = upper limit runoff coefficient for a given land use/soil combination
H = runoff coefficient for a given soil hydrologic unit group defined as:

0 - for soil hydrologic group A;
1/3 - for soil hydrologic group B;
2/3 - for soil hydrologic group C;
1 - for soil hydrologic group D.

Runoff volume [RV] for a delineated unit is the product of is surface area [SA], average rainfall value [R], and runoff coefficient [C]:

$$RV = SA*R*C.$$

Pollutant loading rates for each of the four water quality parameters represent average concentration in measured stormwater runoff from watersheds with homogeneous land use. Animal waste loadings were computed by determining the number of animal units by type per watershed in conjunction with the number of cropland acres in each county.

The pollutant loading for each subwatershed was calculated by summing the loadings associated with land use/soil type and loadings from animal units where appropriate. Total pollutant loadings for each subwatershed was calculated by summing the loadings from all units. To facilitate this process a separate programming code in ARC/INFO was developed during this CRBS.

RESULTS

Higher ranked subwatersheds in Georgia are located in the Basin's western half which include the Alapaha River, Little River, and the Withlacoochee River subbasins. In Florida the higher ranked subwatersheds were on the eastern side of the Santa Fe subbasin; and around the intersection of the Upper Suwannee, Lower Suwannee, and Santa Fe subbasins. Most watersheds with water quality concerns noted in water quality reports were ranked high by the PLSM. There were a few exceptions which can be attributed to limitations inherent in the model and its inputs. These results do not necessarily validate the PLSM, but they do underscore the fact that results of this model are, in general, compatible with current knowledge of nonpoint sources of pollution affecting water quality in surface water bodies. Targeting subwatersheds in this manner is defined by EPA as the "selection of a geographic area for focused remedial or preventative attention and involves marshaling resources and expertise to provide the most efficient and cost-effective solutions for water quality problems."

DISCUSSION

It is important to remind the reader that the purpose of this model is to identify potential for nonpoint source pollution for the purpose of prioritizing subwatersheds. Thus, results of this model represent a comparison of relative pollution potential among subwatersheds. It should also be mentioned that pollution potential was limited to surface water, and human impacts, thus natural background pollutants were not considered.

The PLSM does not account for pollutant loads through infiltration, a natural process that may be as important as surface runoff, especially in karstic areas such as the Gulf Coastal Lowlands where groundwater levels are high. In such areas, soils have lower runoff potentials with high to very high infiltration rates. The PLSM can be modified to include an infiltration component in karstic areas. Potential pollutant loadings would be the sum of runoff and infiltration volumes multiplied by the loading rates for a particular land use/soil type combination.

Another process not included in this version of the PLSM includes actual pollutant transport and transformation during transport and within water bodies, both ground and surface. As mentioned above, the PLSM can be modified to incorporate these processes; however, one should note that these modifications will also require more input. Therefor, resource managers must determine early on in a project the amount of time available to gather and code input data.

LITERATURE CITED

Adamus, C. and M. Bergman, 1993. *Development of a Nonpoint Source Pollution Load Screening Model.* Department of Surface Wate Programs, St. Johns River Water Management District, Palatka, FL.

Florida Nonpoint Source Assessment, Volume One and Volume Two. Florida Department of Environmental Regulation, 1989. Tallahassee, Florida.

Frink, C., P. Stacey, and S. Beede, 1993. *Priority Ranking of Subregional Basins for Nitrogen Management.* Nonpoint Source Work Group, Long Island Sound Study. Long Island, New York.

Georgia Watershed Agricultural Nonpoint Source Pollution Assessment. United States Department of Agriculture, Soil Conservation Service. United States Department of Agriculture, Forest Servcie. 1993. Athens, Georgia.

Kasi, Veronica, 1993. *Using Geographic Information Systems as a Targeting Tool for Pennsylvia's Chesapeake Bay Program.* Bureau of Land and Water Conservations. Pennsylvania Department of Enviornmental Resoruces, PA

Kessler, C. and G. Dugan, 1993. *Colville River Watershed Ranking and Planning Project.* Department of Engineering, University of Hawaii at Manoa. Stevens County Conservation District, Colville, WA.

Matson, R.A., M.E. Rowan, 1989. *The Suwannee River Estuary: An Overview and Research and Management Needs.* American Water Resources Association, Special Publication No. 89-4.

Peterson, G.W., J.M. Hamlet, G.M. Baumer, D.A. Miller, and J.M. Russo, 1991. *Evaluation of Agricultural Pollution Potential in Pennsylvania Using Geographic Information Systems.* ER9105. Environmental Resources Research Institute. University Park, PA.

Plan for Development of the Land and Water Resources of the Southeast River Basins - Suwannee Basin. United States Study Commission, Southeast River Basins, 1963.

Raines, L. and G. Lathem, 1993. *GIS Modeling of Land Use and Associated Nonpoint Source Pollution.* American Water Resources Association, Herndon, VA

Water Quality in Georgia 1992-1993. Georgia Department of Natural Resoruces - Environmental Protection Division, 1994. Atlanta, Georgia.