"DRASTIC" MAPPING TO DETERMINE THE VULNERABILITY OF GROUND-WATER TO POLLUTION

Victoria P. Trent

AUTHOR: Victoria P. Trent, Geologist, Georgia Geologic Survey, 19 Martin Luther King Jr., Dr., SW, Room 400, Atlanta, GA 30334.
REFERENCE: Proceedings of the 1991 Georgia Water Resources Conference, held March 19 and 20, 1991, at the University of Georgia. Kathryn J. Hatcher, Editor, Institute of Natural Resources, The University of Georgia, Athens, Georgia, 1991.

INTRODUCTION

The Georgia Geologic Survey Branch of the Environmental Protection Division, Georgia Department of Natural Resources, in cooperation with the Georgia District of the U.S. Geological Survey, Water Resources Division, is conducting a project to map the relative susceptibility of Georgia's shallow aquifers to ground-water pollution.

The DRASTIC method developed by the U.S. EPA is being used to develop the maps. DRASTIC is a methodology that allows the pollution potential of any hydrogeologic setting to be systematically evaluated. The system has two major portions: the designation of mappable units, termed hydrogeologic settings, and the superposition of a relative rating system (Aller, et. al., 1987)

DRASTIC is an acronym for the hydrogeologic factors which influence pollution potential: depth to water (D), net recharge (R), aquifer media (A), soil media (S), topography (T), impact of the vadose zone media (I), and hydraulic conductivity of the aquifer (C). Each factor is incorporated into a relative rating scheme that uses a combination of weights and ratings to produce a numerical value called the DRASTIC Index (Aller, et. al., 1987). The higher an area scores on the index, the more vulnerable the specific area is to ground water pollution.

METHODS

The seven parameters were derived using three available databases: slope and soils at a scale of 1:250,000, and geology at a scale of 1:500,000. Average depth to water for the shallow water table was derived using a combination of slope and soils databases. Net recharge and topography were mapped as a function of land slope. Ratings for aquifer media, impact to the vadose zone media, and hydraulic conductivity of the aquifer were derived from the geology database. Soil ratings were derived from soil types assigned by soils scientists. All mapping was done utilizing the overlay process of the Georgia Geologic Survey's and the U.S. Geological Survey's geographic information system (GIS).

Ratings for aquifer media, impact to the vadose zone media, and hydraulic conductivity of the shallow aquifers were derived using the geology database. Following DRASTIC methodology (Aller, et. al., 1987), aquifer media ratings and hydraulic conductivity of the aquifer media ratings are assigned a weight of 3, and the impact of the vadose zone media is assigned a weight of 5. Each geologic unit in the geology database was given a numeric rating from 1 - 10, according to its pollution potential. The numeric rating was multiplied by the weight to get a DRASTIC number for the particular geologic unit.

Geologic Unit	DRASTIC Rating	Aquifer Media (weight 3)	Impact of Vadose Zone (weight 5)	Hydraulic Conductivity (weight 3)
Massive sh	1	3	5	3
Meta/ig rock	2	6	10	6
Weath. meta/ig	3	9	15	9
Glacial till	4	12	20	12
Bedded ss,ls,sh	5	15	25	15
Massive ss	6	18	30	18
Massive ls	7	21	35	21
Sand/gravel	8	24	40	24
Basalt	9	27	45	27
Karst ls	10	30	50	30

(Aller, et. al., 1987)

Net recharge and topography were mapped as a function of land slope. Following to DRASTIC methodology, net recharge ratings are given a weight of 4 and topography ratings are given a weight of 1. Areas in the slope database with a slope of less than or equal to 6% are assumed to have a net recharge of 10+ inches per year and are assigned a net recharge DRASTIC rating of 9. Areas in the slope database with a slope of greater than 6% are assumed to have a net recharge of less than 10 inches per year and are assigned a net recharge DRASTIC rating of 8. These rating are multiplied by the weight of 4 resulting in DRASTIC numbers of 36 and 32 respectively. Areas with a slope of less than or equal to 6% are assigned a topography DRASTIC rating of 10. Areas with a slope of greater than 6% are assigned a topography DRASTIC rating of 5. These ratings are multiplied by the weight of 1 resulting in DRASTIC numbers of 10 and 5 respectively.

Slope	DRASTIC Rating	Net Recharge (weight 4)	DRASTIC Rating	Topography (weight 1)
≤6%	9	36	10	10
>6%	8	32	5	5

Soil media ratings were assigned to the soils database according to soil types. The soils parameter was given a weight of 2 in conformity to DRASTIC methodology. Soil media are assigned a rating of 1 - 10, according to their pollution potential. The ratings were then multiplied by the weight of 2 resulting in a DRASTIC number of 2 - 20.

Soil Media	DRASTIC Rating	Soil Number (weight 2)
Thin or absent	10	20
Gravel	10	20
Sand	9	18
Peat	8	16
Shrinking/Aggregated Clay	7	14
Sandy loam	6	12
Loam	5	10
Silty Loam	4	8
Clay loam	3	6
Muck	2	4
Nonshrinking/Nonaggregated clay	1	2

(Aller, et. al., 1987)

Depth to water for the shallow water table was determined by using a combination of slope and soils databases. Following to DRASTIC methodology, depth to water was given a weight of 5. Any areas with a slope of greater than 6% were assumed to have a depth to water of 15 feet and were assigned a DRASTIC rating of 7. For areas with slopes less than 6%, depth to water was determined from soil characteristics and assigned by soils scientists. Areas with a depth to water of greater than 5 feet to 15 feet were given a DRASTIC rating of 9. Areas with a depth to water of less than or equal to 5 feet were given a DRASTIC rating of 10. The ratings were multiplied by a weight of 5 resulting in DRASTIC numbers of 35, 45, and 50 respectively.

Depth to Water	DRASTIC Rating	DRASTIC Number (weight 5)
0'-5'	10	50
5'-15'	9	45
15'	7	35

Once DRASTIC ratings have been assigned for the seven parameters, the pollution potential for a hydrogeologic setting can be determined by computing the DRASTIC Index. The equation for determining the DRASTIC Index is:

$$D_rD_w + R_rR_w + A_rA_w + S_rS_w + T_rT_w + I_rI_w + C_rC_w = \text{Pollution Potential}$$

where: $_r$ = rating
$_w$ = weight.

Once a DRASTIC Index has been computed, it is possible to identify areas which are more likely to be susceptible to ground-water contamination relative to others. The higher the DRASTIC Index, the greater the ground-water pollution potential.

The pollution susceptibility map is a derivative map of the seven parameters which shows three categories: high, medium, and low pollution susceptibility, in accordance with a statewide scoring criteria. Ranges of scores for the low, medium, and high susceptibility categories were chosen so that approximately one third of the area of the state would fall into each category, thus preserving the relativeness of the scoring.

Areas with a DRASTIC Index of less than 141 are considered to have low pollution susceptibility. Areas with scores between 141 and 181 are areas of moderate pollution susceptibility, and areas with scores of greater than 181 are considered to be highly susceptible to ground-water pollution. Scores are relative only within the state of Georgia.

RESULTS

High pollution susceptibility areas in Georgia are most frequent where karst topography is developed on limestones and in some areas of highly porous sandy soils. Areas where the shallow aquifers consist of clayey sand and sandy clay have moderate pollution susceptibility. Areas where shallow aquifers are clayey, or where slope is greater than six percent, have moderate to low pollution susceptibility.

Most of Georgia's Coastal Plain has a high to moderate ground-water pollution susceptibility. Only small areas with a slope of greater than six percent or that are overlain by clayey soils have been given a low susceptibility rating in the Coastal Plain. It is expected that most areas in the Piedmont and Blue Ridge Provinces will have a moderate to low pollution susceptibility, while areas in the Valley and Ridge will have susceptibility ratings ranging from high to low, depending on the geology and slope of a specific area.

USES AND LIMITATIONS

DRASTIC mapping is intended to assist planners, managers, and administrators in evaluating the relative vulnerability of shallow aquifers to ground-water pollution, and to direct resources and land use activities to appropriate areas. As required by the Growth Strategies Planning Act of 1989, the maps will be used by local governments to protect significant recharge areas. The maps may also be used to prioritize protection, monitoring, and clean-up efforts.

DRASTIC maps are not a substitute for site specific investigations, however. Locational inaccuracies in the DRASTIC map may result from utilization of different scales of maps and different sources of maps for the three databases. Though published at a scale of 1:100,000, the derivative map is a compilation of data having scales ranging from 1:100,000 to 1:500,000. Because the individual map layers are from different sources, features from one source may not coincide with features from another source. Overlay accuracy appears to be about one mile or less for boundaries. These maps do not address the potential pollution vulnerability of an area with manmade modifications.

RECHARGE AREA PROTECTION

Chapter 391-3-16, Georgia Rules for Environmental Planning Criteria require higher degrees of ground-water protection in significant ground-water recharge areas. Within significant ground-water recharge areas, the relative degree of protection is further defined on the basis of whether an area is of high, medium, or low susceptibility to ground-water pollution. The susceptibility of an area to pollution, however, is independent of whether an area is a significant ground-water recharge area. For example, the rules specifically require that the lot size for a septic system within a significant ground-water recharge area and within an area denoted as being of high pollution susceptibility be 150% larger than a similar lot in an area not within a significant ground-water recharge area, but still within an area denoted as being of high pollution susceptibility. Larger lot sizes may be recommended in any area of high pollution susceptibility

LITERATURE CITED

Aller, L., Bennett, T., Lehr, J.H., Petty, R.J., and Hackett, G. 1987. DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings. U.S. Environmental Protection Agency, 455 p.

Davis, K.R., Donahue, J.C., Hutcheson, R.H., and Waldrop, D.L. 1989. Most Significant Ground-Water Recharge Areas of Georgia. Georgia Geologic Survey Hydrologic Atlas 18. Scale 1:500,000.

Elassal, A. and Carvso, V. 1984. Digital Elevation Models. U.S. Geological Survey Circular 895-B. 40 p.

_____. 1976. Geologic Map of Georgia. Georgia Geologic Survey. Scale 1:500,000.

_____. 1947. Geologic Map of the Tertiary and Quaternary Formations of Georgia. Georgia Geologic Survey. Scale 1:500,000.

_____. 1981. Major Highways and Roads Digital Line Graph Data. National Cartographic Information Center. Scale 1:100,000.

_____. 1984. Slope Map of Georgia Developed from Analysis of TIN Processed Digital Elevation Model Data (60 meter intervals). U.S. Geological Survey. Scale 1:250,000.

_____. 1990. Soils Map of Georgia Developed from Soil Conservation Service County Soils Series Maps (STATSGO). U.S. Department of Agriculture Soil Conservation Service. Scale 1:250,000.

_____. 1981. Streams, Lakes, and Wetlands Digital Line Graph Data. National Cartographic Information Center. Scale 1:100,000.