UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Review of Hydrogeology, Water Quality and Land Management in the Big Spring Basin, Clayton County, Iowa

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In 1980, Iowa Geological Survey instituted a program to study the hydrogeology, water quality, and land management in the Big Spring Basin, Clayton County, Iowa. The first phase of the study was on the hydrology of the karst-carbonate aquifer areas in northeast Iowa (Hallberg and Hoyer, 1982; DEQ Contract # 81-5500-04). This study provided the detailed geophysical information of the karst-carbonate aquifer and documented significant contamination of groundwater from surface water runoffs due to the shallow aquifer areas in the karst regions. The principal contaminants of public health concern are nitrates, pesticides, bacteria, viruses, and turbidity.

The second phase of the study was on the assessment of groundwater quality in the karst-carbonate aquifers of northeast Iowa.

This study was funded and conducted by Iowa Geological Survey (IGS), Iowa Department of Environmental Quality (DEQ Contract No. 85-5500-02), USDA - Soil Conservation Service (SCS), Iowa Conservation Commission (ICC), University Hygienic Laboratory (UHL), and U.S. Geological Survey. The state institutions concerned with land use and water quality also participated as consultants to this project. At present, the U.S. Environmental Protection Agency is providing direct funding to this project.

The area of the Big Spring basin is ca 103 sq miles. This area was chosen because: (1) the karst in this area formed primarily in limestone and dolostone of the upper Galena group aquifer of Ordovician age, (2) concerns regarding groundwater quality by various state institutions, (3) a major environmental issue of concern to area residents, and (4) ca 11% of area drains entirely to sinkholes.

(1)

Summary

This study was essentially a basin-wide inventory encompassing geology, hydrology, soils, sinkhole locations, land use, piezometric mapping of the surfaces of aquifers, use of agricchemicals, land treatment practices, pesticides application rates, and mapping the boundaries of the groundwater basin using dye-trace studies. The discharge and quality of water was monitored at Big Spring from November 1981 through December 1982.

A variety of quantitative data, procedures and background information is presented in this report. All methodology and analytical procedures are well-described and references are given in the text. The quality assurance procedures were in place in all measurements and methodology used.

The potential soil erosion at Big Spring and runoff for the sinkhole basins under various land treatments were estimated quantitatively by using the Universal Soil Loss Equation (USLE) and the Urban Hydrology for Small Watersheds Model (TR-55), which were developed by U.S. Soil Conservation Service.

The use patterns of pesticides were generalized from interviews and sale records. The most common herbicides used were atrazine and Lasso (in combination). The other herbicides used in lesser amount were Sutan, Ramrod, Prowl, Dual, Eradicane, Roundup, Banvel and 2,4-D. When oats were to follow a corn crop, atrazine was replaced by Bladex. Farmers applied insecticides when corn was grown consecutively. The general order of use was Counter, Amaze, Dyfonate (Fonofos), Thimet, Furadan, Mocap and Lorsban. Other pesticides used on alfalfa or brush included Malathion, Eptam, Alfatox, 2,4,5-T, Paraquat, and Tordon. The rate of application was believed to be the label-recommended application rate.

The pesticide monitoring data were reported on water samples collected as follows: (1) various time intervals from Big Spring, (2) the monitoring well network, (3) various surface water sites, (4) tile lines, and (5) numbers of miscellaneous sites and sediments from Big Spring area. Appendix 4 shows the chemistry, solubility, toxicity and other characteristics of pesticides detected during this study and attached hereto for your detailed information.

The attached Figure 29 of this report shows atrazine concentrations in Big Spring water through various time periods.

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The attached Tables from this report show pesticide concentrations from the Big Spring Basin in detail: Table 32-water and sediments at Big Spring, Table 33 - network wells, Table 34 - surface water, Table 35 - sinkholes, Table 36-tile lines. The attached Figures 43 and 44 show the atrazine concentration (ug/l) in groundwater from monitoring well network in Big Spring basin, June 7, 1982, and July 28, 1982, respectively.

The maximum concentrations and the range of pesticide concentrations in ppb (ug/l) found in Big Spring, network wells, surface water, sinkholes, and tile lines are shown in Table 1 and Table 2, respectively.

The mass balance and hydrograph separation analyses by IGS estimates that ca 84% of pesticides in ground water resulted from infiltration rather than outerflow via sinkholes.

Conclusions

This is a well-designed study of water quality in the Big Spring Basin, Clayton County, Iowa. However many pesticides (herbicides and insecticides) which are used in this basin were not analyzed and/or monitored. The qualitative and quantitative estimation of soil erosion and surface runoff under various land treatment and land management changes are being conducted using computer models in which soil information (soil type, slope, etc.), current land use, geologic, and hydrologic data are all merged into a computer data base.

Atrazine was found in detectable amounts in ground water at Big Spring and most monitored wells within two weeks of application. Atrazine persisted throughout the remainder of 1982 at Big Spring, but dropped below detectable limits in most wells. The atrazine concentration in ground water ranged from 0.04 to 2.5 ppb. Other herbicides (Bladex, Lasso and Dual) were detected in ground water during May and June (application period) only. It is interesting to note that the concentrations of pesticides measured are all very low and well below the Acceptable Daily Intake (ADI) levels. The discharge of pesticides in ground water is only about 14 lb or ca 0.04% of the amount applied in the basin during the 1982 water year. The total loss of pesticides in ground water and streamflow is estimated at 0.4 to 4% of the amount applied, which thus indicates larger surface runoff and smaller vertical leaching of pesticides.

Recommendations

(1) Continued funding by EPA to complete this program is desirable.

(2) A follow-through should be considered on the model estimation of pesticide concentrations in ground water and surface water (runoff) during various land management scenarios involving conservation tillage, crop rotation, strip cropping, integrated pest management, etc., with the State agencies of Iowa and Federal agencies (SCS, USDA, EPA, etc.).

(3) Suggestion should be made to IGS for a determination of other pesticides used in Big Spring Basin regions, and, if necessary, funds for analyses of these pesticides should be allocated.

(4) Provision should be made to incorporate the data in the "STORET" data base or the data base proposed in the National Monitoring Program of the Office of Pesticide Programs.

TABLE 1

Maximum Concentration in ppb (ug/l) of Pesticides in Big Spring Basin

Name of Pesticides	Big Spring		Other Network Wells	Surface Water	Sinkholes (karst)	Tile lines (Infiltration)
	Water	Sediment				
Dieldrin	-	8.0	-	-	-	-
Atrazine	2.5	5.1	0.64	37.00	55.00*	1.4
Lasso (alachlor)	0.15	-	-	20.00	12.70	1.5
Bladex (cyanazine)	0.2	-	0.2	5.00	31.00	6.5
Dual (metolachlor)	-	-	-	6.00	-	-
Dyfonate (fonofos)	-	-	-	0.36	-	-
Sencor (metribuzin)	-	-	-	-	1.50	-

- Blank space means pesticides were not analyzed and/or reported.

* Sheetwash runoff from corn field; otherwise the maximum concentration was 6.30 ppb (ug/l)

TABLE 2

Range of Pesticide Concentrations in ppb (ug/l) in Big Spring Basin

Names of Pesticides	Big Spring Water	Other Network Wells	Surface Water	Sinkholes (karst)	Tile lines (Infiltration)
Dieldrin	0.65 - 8.0*	-	-	-	-
Atrazine	0.10 - 2.5	0.04 - 0.64	0.30 - 37.00	0.13 - 6.30**	0.15 - 1.4
Lasso (alachlor)	0.05 - 0.15	-	0.06 - 20.00	0.30 - 12.70	0.16 - 1.5
Bladex (cyanazine	0.07 - 0.2	0.11 - 0.2	0.15 - 5.00	7.20 - 31.00	0.08 - 6.5
Dual (metolachlor)	-	-	0.05 - 6.00	-	-
Dyfonate (fonofos)	-	-	0.09 - 0.36	-	-
Sencor (metribuzin)	-	-	-	0.10 - 1.50	-

- Blank space means pesticides were not analyzed and/or reported

* Sediment only

** Sheetwash runoff from corn field was 55.00 ppb (ug/l)