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Nonpoint-source pollution is closely linked to land use in the Lake Erie and Lake Saint Clair drainage basins, USGS report says

The quality of streams and ground water in the Lake Erie-Lake Saint Clair drainage basin is closely linked to present and past land use and the chemicals used in urban and agricultural areas. This is the major finding of a study undertaken during 1994-2000 by the U.S. Geological Survey (USGS). The Lake Erie-Lake St. Clair drainage basin is a 22,300-square-mile area that drains to the Great Lakes from parts of Michigan, Indiana, Ohio, Pennsylvania, and New York (see map inset).

Pollutants associated with urban- and agricultural-land use cannot be regulated at the end of a pipe as most other pollutants are. The pollutants that come from the land surface are considered "nonpoint-source pollutants" and are mostly unregulated, according to Donna Myers, a USGS hydrologist and primary author of the 40-page report. "This is the first comprehensive study that specifically examines nonpoint sources of pollution in streams and ground water in the watershed that drains to Lake Erie and Lake Saint Clair" Myers said. "We found that land use and associated human activities like transportation, agriculture, residential development, and past industrial land use have affected streams and aquatic biota, and to a lesser extent, ground water in shallow wells."

The major influences on stream-water quality were found to be chemical releases associated with land use. "We found a strong association between land use, chemical applications, and detections of chemicals in stream water. The chemicals applied most heavily were the ones detected in 50 to 100 percent of the 300 samples collected in 10 streams during 1996-98," Myers said.

In agricultural and urban areas, the chemicals most heavily applied to the land are fertilizers, herbicides (weed killers), and insecticides. Carried into streams by storm runoff, some of the most heavily used pesticides were detected at or above the standards for drinking water or guidelines for the protection of aquatic organisms for four to six weeks after application. Usually when one pesticide was detected, so were others. "One sample contained 27 different pesticide compounds, but the effects of these mixtures on human health and aquatic life are poorly understood," Myers stated. Some public water–supplies remove pesticides by treating their raw water to meet Federal drinking-water standards. For some large cities, the cost of treatment can be hundreds of thousands of dollars per year.

The study also found that levels of phosphorus and nitrate—mainly from fertilizers—and levels of some pesticides were in the highest 25 percent of samples collected by the USGS nationwide in 35 major river systems during 1991-98. Although phosphorus and nitrate at these levels can result in excessive algae growth in streams, the Federal drinking-water standard for nitrate was rarely exceeded. Levels of phosphorus in more than 60 percent

of samples collected from 8 streams were at or above the level recommended for the prevention of nuisance aquatic-plant growth. "Major rivers flowing through agricultural and mixed-use land were found to be major sources of phosphorus to Lake Erie. According to other U.S. and Canadian scientists who study water quality in Lake Erie, the levels of phosphorus in the lake appear to be on the rise again, after two decades of decline." Myers said. The governments of the United States and Canada have invested many millions of dollars to reduce phosphorus concentrations in the Great Lakes.

A positive finding from the study was that fish species sensitive to pollution are able to coexist with agriculture—even when agriculture is the primary land use—if streams are protected by natural vegetative cover. Trees and shrubs, especially along streambanks, can prevent erosion and intercept and filter runoff from farm fields. Another positive finding from the study was that when farmers used conservation tillage on at least half their crop fields, as they did in northwestern Ohio and northeastern Indiana during 1993-98, the amount of sediment eroded from farm fields and carried by streams was noticeably reduced.

The study found that contamination of streambed sediments was prevalent in streams receiving runoff from urban and mixed-use lands. Contaminants detected most often in bed sediments were arsenic, cadmium, copper, lead, mercury, zinc, PCBs (polychlorinated biphenyls) and PAHs (polycyclic aromatic hydrocarbons). PCBs were formerly used as fire retardants and as additives in a number of industrial and commercial products. PAHs are byproducts of combustion, petroleum refining, and steelmaking. Levels of mercury, PCBs, and PAHs equaled or exceeded levels associated with possible adverse effects on aquatic life in 11 to 30 percent of bed-sediment samples.

The most frequently detected contaminants in fish were highly persistent organochlorine pesticides (DDT, chlordane, dieldrin), PCBs, and mercury. Except for mercury, use of these chemicals in industry and agriculture in the United States and Canada was discontinued 15 to 25 years ago. Detections of PCBs, DDT, chlordane, dieldrin, and mercury in the tissues of fish indicate bioaccumulation—and in some fish species, these levels may be a health risk to fish-eating wildlife.

Ground water, where studied in the Lake Erie-Lake Saint Clair basin, appeared to be less contaminated than streams in similar land-use areas. "Land use determines which chemicals are used; but how readily these chemicals are transported to the ground water is affected by the types of soils and sediments that overlie the aquifer," said Mary Ann Thomas, USGS hydrologist and author of the ground-water section in the report. The glacial aquifer that lies above bedrock is the major source of drinking water in northwestern Ohio, southeastern Michigan, and northeastern Indiana, where ground-water quality was sampled in two studies during 1996-98.

Ground water in residential areas outside Detroit, Michigan, has become increasingly more contaminated over the last 50 years by substances derived from human activities. "In residential areas underlain by sand and gravel, 75 percent of ground water representing the urbanized time period showed elevated levels of chloride, nitrate, and common organic chemicals such as solvents, cleaners, industrial compounds, and components of transportation fuels," Thomas said. Probable sources are septic systems, roads, and lawns. Pesticides used on lawns and along roadways, however, were rarely detected.

In a study of agricultural areas underlain by silt and clay, 37 percent of wells showed elevated levels of nitrate and 41 percent of wells showed detections of herbicides or herbicide by-products. "No drinking-water standards were exceeded in any of the domestic wells sampled," Thomas said.

Lower levels of human-derived substances were found in ground water in the Lake Erie-Lake Saint Clair basin than in ground waters studied in 35 areas across the Nation. This finding supports, to some degree, the common belief that the soils and overlying sediments common to this region of the Great Lakes protect the ground water from contamination.

Copies of the 40-page, color report, "Water Quality in the Lake Erie-Lake Saint Clair Drainages, Michigan, Ohio, Indiana, New York, and Pennsylvania, 1996-98", by Donna N. Myers, Mary Ann Thomas, Jeffrey W. Frey, Stephen J. Rheaume, and Daniel T. Button, published as USGS Circular 1203, are available free of charge by writing the USGS Branch of Information Services, Box 25286, Denver Federal Center, Denver, CO 80225, (or by calling 1-888-ASK-USGS.) The circular may be viewed on the World Wide Web at http://water.usgs.gov/nawqa/.

The USGS assessment is part of a national program, currently releasing results on surface and ground water in 15 additional major river basins and aquifer systems across the Nation. Check the status and availability of the individual basin reports on the USGS website, as well as accessibility to other publications and national data sets and maps.

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