## 2.2 Water Quality

***The majority of the Nation's rivers, lakes, and estuaries support designated uses (such as drinking water supply, as defined by the Clean Water Act), and are fishable or swimmable. Groundwater quality, in general, is good. However, agricultural chemicals and sediment are impairing the quality of some water resources, often imposing costs on water users.***

Water quality problems thought to be related to agricultural production have received considerable attention in recent years. Modern farm production practices, which use agricultural chemicals, benefit consumers through lower prices and increased output. However, the consequences of farm production, including soil erosion, runoff into rivers and streams and leaching into ground water, and conversion of wetlands to crop production, may impair the quality of the Nation's water resources. These off-farm environmental effects may impose costs on users, such as damaged fish and wildlife resources, potential health hazards, threatened natural environments, and lost recreational opportunities. Federal and State efforts to protect and improve the quality of our water resources are increasingly emphasizing prevention of water pollution from agricultural sources.

Controlling agricultural sources of pollution can be difficult, because it is frequently impossible to trace the source of the water impairment back to any particular source (such as a farm or livestock operation). Partly for this reason, efforts to clean up the Nation's water resources have focused on identifiable, "point" sources of pollution such as sewage treatment plants and factories. However, increasing emphasis is being placed on reducing agricultural and other "nonpoint" sources of pollution.

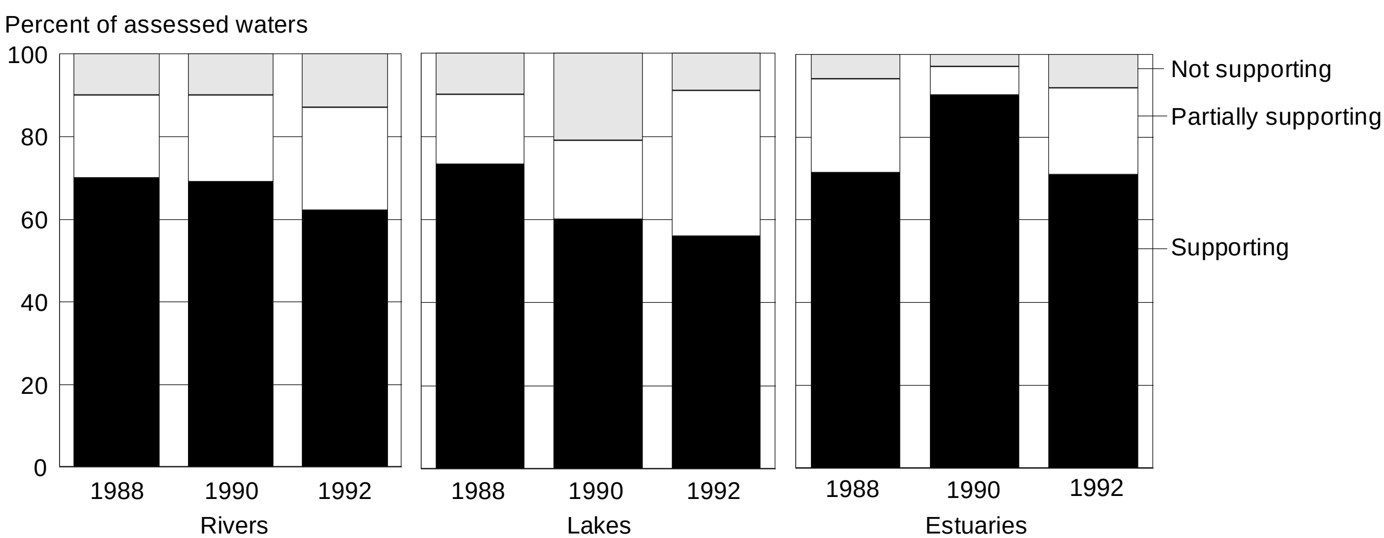
### The Majority of the Nation's Waters Meet Designated Quality Standards

The U.S. Environmental Protection Agency (EPA) reports biennially to Congress on the status of the Nation's water quality. These reports summarize information provided to the EPA under Section 305(b) of the Clean Water Act, which requires periodic State assessments of the quality of lakes, rivers, and coastal waters. Although the coverage of these assessments varies from State to State, and the States use diverse standards as to what defines water quality, these data provide some insights about the Nation's water quality.

Under the Clean Water Act, the States establish what are called "designated uses" for their water bodies. These designated uses include, for example, high-quality cold water fishing, drinking water supply, and swimming or other forms of recreational use. In 1992

Figure 2.2.1

**Surface waters meeting designated uses, 1988-92**




Source: U.S. EPA, 1990, 1992, 1994.

**Table 2.2.1—Status of the Nation's surface-water quality, 1988-92**

| Item | Rivers | | | Lakes | | | Estuaries | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1988 | 1990 | 1992 | 1988 | 1990 | 1992 | 1988 | 1990 | 1992 |
| | *Percent of total waters*[1] | | | | | | | | |
| Water systems assessed | 29 | 36 | 18 | 41 | 47 | 46 | 76 | 75 | 74 |
| | *Percent of assessed waters*[1] | | | | | | | | |
| Meeting designated uses: | | | | | | | | | |
| Supporting | 70 | 69 | 62 | 74 | 60 | 56 | 72 | 90 | 68 |
| Partially supporting | 20 | 21 | 25 | 17 | 19 | 35 | 23 | 7 | 23 |
| Not supporting | 10 | 10 | 13 | 10 | 21 | 9 | 6 | 3 | 9 |
| Clean Water Act goals: Fishable | | | | | | | | | |
| Meeting | 86 | 80 | 66 | 96 | 81 | 64 | 86 | 97 | 94 |
| Not meeting | 11 | 19 | 26 | 4 | 19 | 33 | 14 | 3 | 4 |
| Not attainable | 3 | 1 | 8 | -- | -- | 3 | -- | -- | 1 |
| Clean Water Act goals: Swimmable | | | | | | | | | |
| Meeting | 85 | 75 | 71 | 95 | 93 | 77 | 95 | 96 | 83 |
| Not meeting | 11 | 15 | 10 | 5 | 7 | 16 | 4 | 2 | 12 |
| Not attainable | 4 | 10 | 19 | -- | -- | 7 | 1 | 2 | 5 |

-- = Less than 1 percent of assessed waters.

[1]Percent of river miles, lake acres, and estuary square miles.

Source: U.S. EPA, 1990, 1992, 1994.

(the most recent year for which data are available), 56 percent of river miles, 43 percent of lake acres, and 56 percent of estuarine waters assessed by the States were found to fully support the uses designated for them (table 2.2.1, fig. 2.2.1).

Another measure of water quality is the degree to which water bodies meet the goals of the Clean Water Act, which is a level of water quality that "provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water." These goals are commonly referred to as "fishable" and "swimmable." In 1992, the "swimmable" standard was met by 95 percent or more of assessed lake acres and coastal miles, but only 71 percent of river miles.

The overall quality of lakes and rivers may be declining. The share of rivers supporting designated uses fell from 70 percent in 1988 to 62 percent in 1992; the share of lakes meeting designated uses fell from 74 percent to 56 percent. Estuarine water quality may be improving. The share of estuarine waters supporting designated uses increased from 72 percent in 1988 to 78 percent in 1990. However, these estimates should be interpreted with caution because only 18 percent of rivers and 46 percent of lakes were assessed in 1992.

Less is known about the overall quality of the Nation's groundwater resources. Unlike surface-water systems, no comprehensive nationwide groundwater quality data exist. However, 1992 Section 305(b) reports indicate that "the Nation's groundwater quality is good to excellent. Thirty-eight States made some judgment concerning the quality of their ground water; 11 States judged their groundwater quality to be excellent, 18 judged their groundwater quality to be good, and 9 reported that overall water quality was variable or poor. Generally, degradation has occurred only in local areas" (U.S. EPA, 1992).

The most comprehensive assessment of the extent of agricultural chemicals in ground water comes from the EPA's National Pesticide Survey. The survey showed that while at least half of the Nation's drinking water wells contained detectable amounts of nitrate, only about 1.2 percent of community water systems and 2.4 percent of rural private domestic wells contained nitrates at levels higher than EPA's recommended levels. About 10 percent of community wells and 4 percent of domestic wells contained detectable levels of one or more pesticides, but the EPA estimates that less than 1 percent of the wells contained pesticides at concentrations higher than those considered to pose an unacceptable risk to human health (U.S. EPA, 1990a).

**Table 2.2.2—Sources of identified impairments to surface-water quality, 1988-92**

| Source of impairment | Rivers 1988 | Rivers 1990 | Rivers 1992 | Lakes 1988 | Lakes 1990 | Lakes 1992 | Estuaries 1988 | Estuaries 1990 | Estuaries 1992 |
|---|---|---|---|---|---|---|---|---|---|
| | *Percent of impaired waters*[1] | | | | | | | | |
| Agriculture | 56 | 61 | 72 | 58 | 57 | 56 | 19 | 18 | 43 |
| Hydro/habitat modification | 13 | 15 | 7 | 33 | 40 | 23 | 5 | 5 | 10 |
| Storm runoff/sewers | 13 | 11 | 11 | 28 | 28 | 24 | 39 | 37 | 43 |
| Land disposal | 4 | 4 | NA | 26 | 24 | 16 | 27 | 19 | NA |
| Municipal/industrial | 25 | 25 | 22 | 23 | 26 | 21 | 65 | 45 | 76 |
| Other | 28 | 33 | 19 | 8 | 26 | 29 | 48 | 17 | 12 |

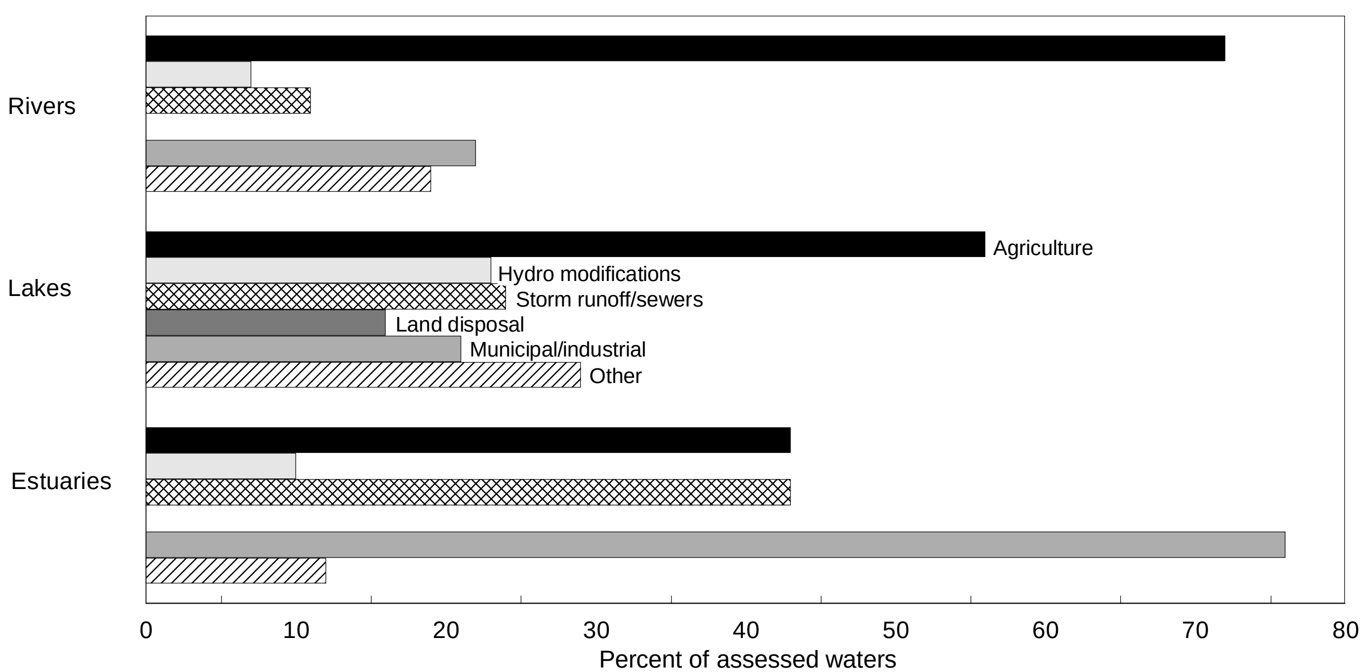
NA = not available.
[1]Percents of river miles, lake acres, and estuary square miles add to more than 100 due to multiple impairments.
Source: U.S. EPA, 1990, 1992, 1994.

## Agricultural Sources of Water Pollution Are Widespread

Since the passage of the Federal Water Pollution Control Act Amendments of 1972, point sources of pollution have been subject to increased control. With dramatic decreases in point-source pollution from industries and municipalities, nonpoint sources of pollution have become the largest water pollution problem, with related impairments, such as higher nutrient and sediment content, increasingly evident.

The 305(b) reports provide evidence of agricultural sources of surface-water pollution. Agriculture is listed as a major or minor contributor to water quality problems in 72 percent of river miles and 56 percent of lake acres identified by the States as being "impaired" (table 2.2.2, fig. 2.2.2). By contrast, agriculture was listed as a major or minor source of pollution in 43 percent of estuarine waters. Siltation and nutrients, caused partly by runoff from cropland, were the two most important single causes of impairments of lakes and rivers (table 2.2.3).

Figure 2.2.2
**Sources of identified impairments to surface-water quality, 1992**




Source: U.S. EPA, 1994.

**Table 2.2.3—Causes of impairments, 1988-92**

| Cause of impairment | Rivers 1988 | Rivers 1990 | Rivers 1992 | Lakes 1988 | Lakes 1990 | Lakes 1992 | Estuaries 1988 | Estuaries 1990 | Estuaries 1992 |
|---|---|---|---|---|---|---|---|---|---|
| | *Percent of impaired waters*[1] | | | | | | | | |
| Siltation | 42 | 36 | 45 | 25 | 13 | 22 | 7 | 5 | 12 |
| Nutrients | 27 | 28 | 37 | 49 | 32 | 40 | 50 | 55 | 55 |
| Pathogens | 19 | 19 | 27 | 9 | 2 | 8 | 48 | 30 | 42 |
| Organic enrichment | 15 | 26 | 24 | 25 | 19 | 24 | 29 | 31 | 34 |
| Pesticides | 10 | 11 | 26 | 5 | -- | 9 | 1 | 2 | 7 |
| Suspended solids | 6 | 11 | 13 | 7 | 13 | 6 | -- | 9 | 11 |
| Salinity | 6 | 12 | 12 | 14 | 4 | -- | -- | -- | 7 |
| Metals | 11 | 14 | 6 | 14 | 48 | 41 | 10 | 7 | 4 |
| Other | 21 | 29 | 19 | 27 | 34 | 35 | 33 | 18 | 15 |

-- = Less than 1 percent of assessed waters.

[1]Percents of river miles, lake acres, and estuary square miles add to more than 100 due to multiple impairments.

Source: U.S. EPA, 1990, 1992, 1994.

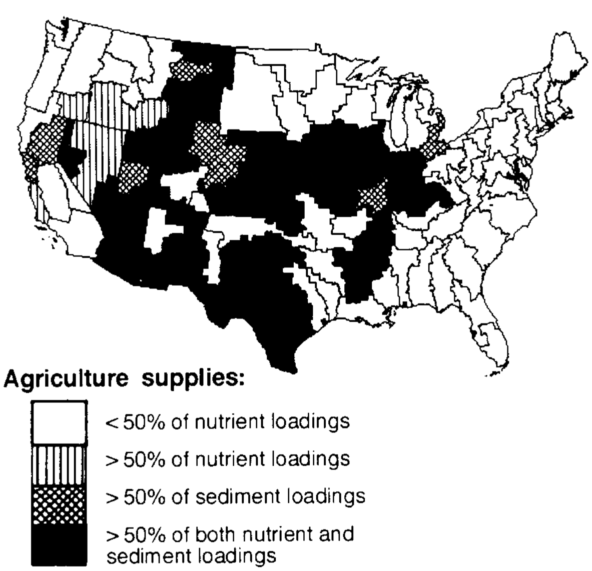
Runoff from cropland contributes much of the sediment and nutrients reaching freshwater systems. Water systems impaired by agricultural sources are found primarily in the Corn Belt, Southern Plains, and Great Plains regions. Although localized water quality problems related to agricultural runoff are found in the Eastern States (for example, the Chesapeake Bay), agricultural pollution of surface waters is less of a problem in the East (fig. 2.2.3).

Another source of agriculture-related water quality impairment is runoff from livestock operations. Confined animal facilities can be sources of pathogens and nitrogen from animal waste. According to the EPA, runoff from confined feedlots caused 7 percent of lake and 13 percent of river impairments in 1990. Impairment of inland waters from feedlots is greater in the Southern Plains and Southeast than nationally, while impairment of estuaries from feedlots is greatest in the Southeast.

The scope and extent of agricultural sources of groundwater pollution are less well documented than for surface waters. Studies of groundwater vulnerability at the national level have combined estimates of the physical characteristics of cropland with estimates of agricultural chemical use and available water quality data. Kellogg, Maizel, and Goss identified areas where hydrogeologic conditions appear to favor the movement of chemicals to aquifers and where agricultural practices using large amounts of leachable pesticides are found (fig. 2.2.4). The Corn Belt, Southeast, and Lake States have more acreage thought to be vulnerable to leaching and treated with pesticides that tend to leach. Conversely, the Northern and Southern Plains show more acreage with a potential for nitrate leaching than for pesticide leaching (fig. 2.2.5).

Vulnerability does not necessarily indicate contamination. Aquifers considered vulnerable to leaching may not be contaminated. The time factor must be kept in mind as well. Even if an aquifer is found to be free from chemical residues, it may take years for a "plume" of chemicals applied to cropland to leach through overlying soil into aquifers.

Figure 2.2.3
**Agricultural sources of surface water pollution**




Source: Ribaudo, 1986.

Figure 2.2.4

Extent of potential ground-water vulnerability to agricultural pesticide leaching

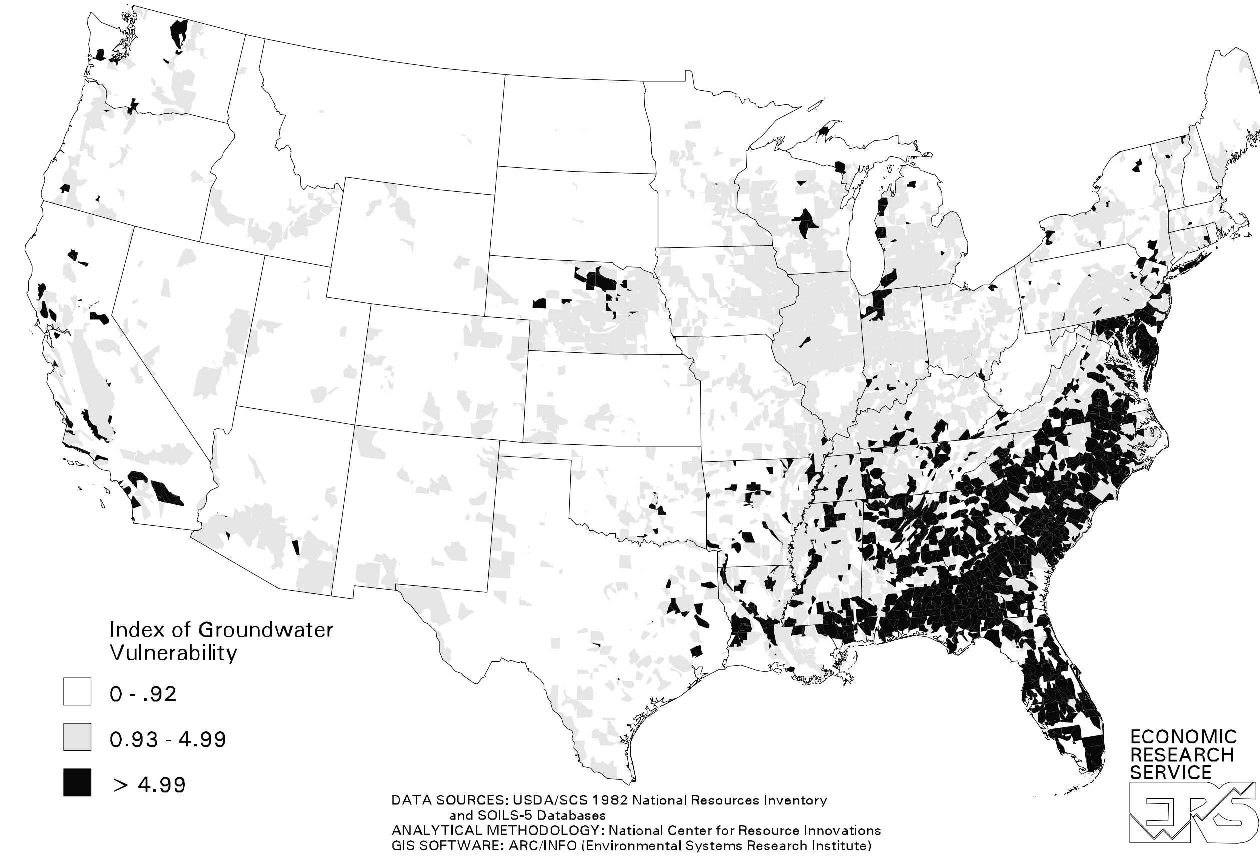
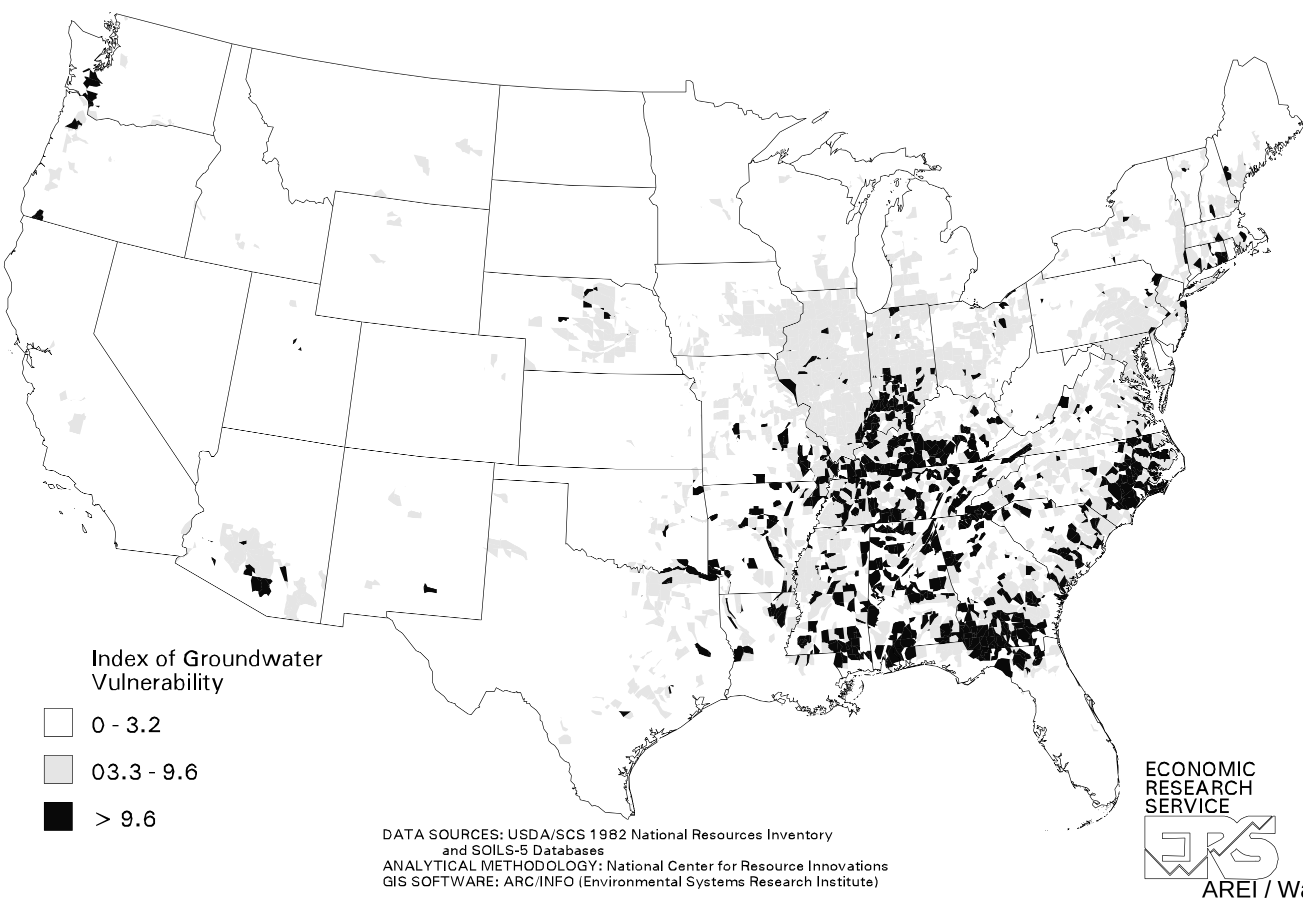



Figure 2.2.5

Extent of potential ground-water vulnerability to agricultural nitrate leaching



Nationwide assessments of vulnerability mask some localized variability arising from specific local hydrogeologic conditions.

### Other Agricultural Impairments Include Salinization and Wetlands Degradation

In addition to surface and groundwater impairments, agricultural production can have other off-farm consequences for water quality. Wetlands serve important ecological functions that can be lost if they are drained or subjected to excessive levels of contamination by farm chemicals and runoff. When wetlands are drained or degraded by pollution, their direct and indirect environmental benefits, such as fish and wildlife habitat, water cleaning capacity, and flood control, are reduced.

The area of wetlands drained has been substantial. The U.S. Fish and Wildlife Service estimates that over half (53 percent) of the original acreage of wetlands in the contiguous 48 States was lost by the mid-1980's (see module 6.4). According to the EPA, agricultural activities affecting wetlands, including drainage, filling, and road construction, were responsible for 87 percent of the losses between the mid-1950's and mid-1970's. From the mid-1970's to mid-1980's, 54 percent of wetlands loss was attributed to agricultural activities (EPA, 1992). The "Swampbuster" provision of the Food Security Act of 1985 denies farm program benefits to farmers who drain wetlands. This provision has slowed, though not eliminated, wetlands loss. Recent Federal policy initiatives stress the role of habitat restoration and preservation to protect remaining wetlands.

Irrigation return flows are a source of water quality problems, especially in the irrigated regions of the West. Irrigation can flush salts out of the soil. When the irrigation water is returned to the source, increased concentrations of salts and metals can result. Increased salinity is a problem in much of the West. In addition, metals such as selenium that leach out of the soil and reach water systems via irrigation return flow can be harmful to wildlife, particularly migratory waterfowl.

### Agriculture-Related Water Quality Problems Have Economic Consequences

When making production decisions, farmers balance their expected private costs of various production options, including tillage practices and chemical use, with returns from crops produced. However, farmers' decisions may have unintended effects; consumers of water resources may bear the costs when agricultural runoff, sediment, or farm chemicals degrade the quality of these resources. Though the public may place a value on these lost resources, this value is not fully reflected in farmers' cost/benefit calculations in deciding how to produce a crop.

When the value of these water resources is impaired by agricultural chemical pollution, economic losses can take a number of forms, including costs of providing alternative sources of drinking water, increased treatment costs for public and private water systems, lost boating and swimming opportunities, and damage to valuable recreational and commercial fishery resources. Because prices paid by users of agricultural chemicals do not include these off-farm costs, market prices of these inputs do not fully reflect their social cost.

Although the economic costs of agriculture-related water quality problems (and the benefits of protecting and improving water quality) are difficult to measure, studies indicate that the cost to society of impaired water quality is substantial. One study estimates the costs of impaired water quality from cropland erosion alone to be $2-$8 billion per year, with a "best guess" estimate of $3 billion per year. These costs primarily consist of damage to freshwater use (recreation, fishing, and boating), water storage facilities, navigable waterways (as silt requires dredging), commercial fishing, and municipal treatment plants (Ribaudo, 1987).

The costs of groundwater contamination are less well known, in part because the scope and extent of actual contamination is still unclear. In addition, the primary issue of concern, placing a value on human health effects of exposure to agricultural chemicals, represents a very difficult challenge. One measure of the cost of groundwater contamination is the cost society would have to pay to reduce the risk of exposure by monitoring private and public wells for the presence of pesticides and nitrates. One study put the cost of testing private drinking water wells on a one-time basis in potentially vulnerable areas to be between $890 million and $2.2 billion (Nielsen and Lee, 1987). Other studies surveyed individuals to determine their willingness to pay for assurance that their drinking water systems were free of agricultural chemicals. Estimates of this willingness to pay have ranged from $50 per household per year to over $1,000 per household per year (Crutchfield, 1994). Research is under way at ERS to better estimate the benefits of reducing the risk of agricultural contamination of surface and ground-water supplies.

Programs designed to maintain or improve water quality are discussed in chapter 6.

*Author: Stephen R. Crutchfield, (202) 501-7415.*

*Contributor: David Letson, (202) 501-8379.*

***References***

*Crutchfield, Stephen R. (1994). "Estimating the Value of Ground Water Protection: An Application of Benefits Transfer." Paper presented at the Annual Meetings of the American Agricultural Economics Association, San Diego, CA, Aug .*

*Kellogg, Robert, Margaret Maizel, and Donald Goss (1993). "Agricultural Chemical Use and the Potential for Ground Water Contamination: How Big Is the Problem?" U.S. Dept. Agr., Econ. Res. Serv., Soil Cons. Serv., Coop. State Res. Serv., and National Center for Resource Innovations.*

*Nielsen, Elizabeth G., and Linda K. Lee (1987). The Magnitude and Costs of Groundwater Contamination from Agricultural Chemicals*. AER-576, U.S. Dept. Agr., Econ. Res. Serv., Oct.

Ribaudo, Marc O. (1986). "Targeting Soil Conservation Programs." *Land Economics*, Vol. 82, No. 4., Nov.

Ribaudo, Marc O. (1987). "Agriculture's Impact on Water Quality." *Agricultural Resources: Cropland, Water and Conservation Situation And Outlook Report*, AR-8, U.S. Dept. Agr., Econ. Res. Serv., Sept.

U.S. Environmental Protection Agency (1988). *National Water Quality Inventory: 1986 Report to Congress*. EPA-440/4-87-008, Apr.

______ (1990). *National Water Quality Inventory: 1988 Report to Congress*. EPA 503-9-92440-4-90-003, Apr.

______ (1992). *National Water Quality Inventory: 1990 Report to Congress*. EPA 503-9-92-006, Apr.

______ (1994). *National Water Quality Inventory: 1992 Report to Congress*. EPA 841-R-94-001, Mar.

______ (1990). National Pesticide Survey Phase 1 Report. EPA 570/9-90-003, Sept.