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AGRICULTURE'S ROLE IN NONPOINT SOURCE POLLUTION

Pesticides Are Not A Large Problem in Groundwater, But Nitrate Levels May Exceed Standards

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Pollutants that can be linked to a specific source are referred to as "point" sources of pollution. Examples include a municipal treatment plant that discharges wastewater into a river, or someone who spills chemicals down an open well and contaminates a groundwater supply.

In contrast, nonpoint pollution cannot be traced to a specific source. Once it is linked to an identifiable source, it becomes a point source.

What kind of a dilemma does nonpoint source pollution pose? Many cases of nonpoint source pollution are caused when heavy rains sweep a wide array of pollutants (including sediments, pesticides, fertilizers, plant debris, fecal bacteria and others) into rivers and streams. Even though specific pollutants may be detected downstream, it's hard to target which activity is responsible. For example, it may be obvious that excess amounts of nitrogen and phosphorous have run off into a lake, but it may be nearly impossible to determine if the pollution resulted from agricultural practices, landscapes, or septic tanks. In some cases, pollution which may appear to be caused by man's activities may actually be the result of naturally occurring contaminants like salts.

Nonpoint sources may also pollute groundwater supplies. Pollution is most likely when excess amounts of agricultural pesticides and fertilizers are applied on highly permeable soils or areas with shallow groundwater systems. Heavy rains following chemical application also increase pollution risks. Septic tank and landfill wastes can also seep through soils and contaminate groundwater supplies.

Despite the seeming complexity of the problem, there are some "common sense" solutions that can improve water quality. Most of these strategies involve the use of best management practices (BMPs) that lessen the amount of chemical inputs and reduce erosion, runoff and drainage.

Gathering more information about the linkages between agriculture and nonpoint sources of pollution is important for many reasons. If agricultural activities are introducing pollutants into rural groundwater systems, they will likely pose a health threat. Because many rural wells are not tested on a regular basis, residents may not know their water is contaminated and suffer long-term exposure. Knowing whether excess application of fertilizers and pesticides are causing pollution problems in specific instances saves producers money and benefits the environment. No one wins when resources are wasted.

Basic Information

Many nonpoint sources are linked to land use practices including agriculture, forestry, mining, transportation, landfills, and construction. Improper land management can increase the amount of pollutants that are carried in runoff after heavy rains.

Agricultural production, dairy and feedlot operations, construction, and natural processes can all produce increased sedimentation. Sediments also bind other pollutants that are transported in runoff. Excess amounts of sediments can make rivers and streams more turbid and can reduce the volume of water that can be stored behind dams. Some sedimentation and erosion also occurs naturally. Sediments are needed to form river deltas (which create fertile agricultural lands) and marshes, and provide essential nutrients to bays and estuaries. However, too little or too much sediment can destroy fragile ecosystems. The TWC views sediments as nonpoint source pollutants only when they exceed naturally occurring levels. The TWC recognizes contaminants transported by sediments as nonpoint source pollutants.

Nitrates are a critical nonpoint source pollution problem, especially in groundwaters. In rare cases, high nitrate levels can cause death in infants who drink contaminated water. Septic tanks, fertilizers, and animal wastes can.all increase nitrate levels in surface and ground waters. Runoff into surface waters can lead to increased algal growth and eutrophication. Not all nitrate problems are caused by man's activities. Many groundwater systems in Texas have naturally occurring high nitrate levels.

Pesticides, herbicides, and toxic chemicals used in agricultural production can also pollute surface and ground water. Many newer chemicals quickly degrade into less harmful by-products after being applied to reduce nonpoint source pollution risks. Some older chemicals that are more persistent are still found in the environment many years after being applied.

Pathogens and disease-causing microorganisms are introduced from liquid wastes and fecal matter produced by cattle, poultry, and other domestic animals, wild animals, and human waste in septic tanks.

Even though agricultural activities are believed to be a major contributor to nonpoint source problems, it's difficult to establish that's the case. Many different practices can increase sedimentation, raise levels of nitrogen, and produce fecal bacteria. As a result, it's hard to identify activities that are responsible for nonpoint source problems, although isotope analysis may be helpful in some cases (Kreitler, 1989).

National Studies

According to the EPA, agriculture comprises the most pervasive sources of nonpoint pollution of surface waters in the U.S.

Agricultural nonpoint source pollutants can threaten both surface and ground water. EPA estimates that 25 to 40% of the soil eroding from croplands reaches a water body. EPA (1984) also predicts that more than 6.8 million tons of nitrogen and 2.6 million tons of phosphorus run off to surface waters annually, accounting for nearly 70% of the total loads of these pollutants.

However, it doesn't appear that normal use of agricultural chemicals is causing widespread groundwater pollution.

Isolated cases of groundwater contamination were reported in rural areas throughout the U.S. in the EPA National Pesticide Survey (1990). Results of the survey showed that more than 10% of community water systems (COOS) and more than 4% of rural domestic wells contained at least one pesticide in detectable amounts that would not cause sign)ficant health problems. EPA estimates as many as 9,500 CWS wells and 60,900 rural individual wells could be impacted nationally. No CWS wells and only 0.6% or rural domestic wells that were tested exceeded pesticide Maximum Contaminant Levels (MCLs) set by EPA. Roughly half of the wells contained detectable levels of nitrate. More than 1 % of CWS wells and 2% of rural domestic wells exceeded the nitrate MCL of 10 mg/L.

Monsanto conducted a national survey of alachlor levels in groundwater as part of the re-registration process for some of its herbicides. Results estimate that more than half the wells in the alachlor use area are expected to contain nitrate. Roughly 5% of wells that were tested exceeded the MCL for nitrate, and just 0.02% exceeded the MCL for alachlor. Detectable levels of atrazine were found in about 12% of rural wells, but alachlor was present in less than 1% of rural wells (Klein, 1990).

A recent study by the Congressional Office of Technology Assessment (Hess, 1989) showed that pesticides had been detected in groundwater from 28 states.

While pesticide detections are of concem, the most widespread and serious problems appear to be associated with nitrate contamination.

Texas Studies

Is agriculture causing nonpoint source pollution problems in Texas? Although some recent national studies suggest that agriculture may be causing increased levels of pesticides in rural drinking water wells, there is little evidence that is occurring in Texas. However, dairy operations and nutrient applications to croplands are contributing to increased levels of fecal colifomm bacteria and nitrates in surface and ground waters.

The TWC recently assessed surface and ground water systems impacted by nonpoint source pollution (TWC, 1990). The report shows that 37 surface water bodies are "known" to be impacted by nonpoint sources of pollution. Problems that were identified include runofffrom range, cropped and urban lands; naturally occurring contaminants (mainly salinity); oufflows from septic tanks, pesticide and nutrient application; petroleum exploration; erosion from agricultural tillage practices and construction sites, golf course runoff and others (see Table 1). Contaminants that were found include sediments, chlorides, sulfates, phosphorus, nitrogen, nitrate, total dissolved solids, fecal coliform bacteria, trash and debris, fertilizers and pesticides, and heavy metals such as mercury and lead.

More than 70 other lakes, rivers and streams are identified as "potentially" having nonpoint source pollution problems.

Examples of problems listed in the report included runoff of dairy wastes that led to high levels of fecal bacteria in the Upper North Bosque River (the State's worst problem); increased nutrient loadings from croplands into Lake BeHon; runoff from agricultural, forested and mined lands that is increasing sedimentation in reservoirs in the Sabine River Basin; and naturally occurring saline water in lakes and rivers in West and Central Texas that is polluting fresh water rivers.

No groundwater systems were listed as "known" to be contaminated, but the Ogallala, Seymour, and Carrizo aquifers were assessed to "potentially" be impacted by nonpoint sources. Additional information on the susceptibility of groundwater systems to agricultural pollution has also been developed by the TWC. The TWC used the DRASTIC methodology to rank and map areas where groundwater pollution may be a problem. Work is now under way to computerize DRASTIC data so it can easily be retrieved (TWC, 1989). Little information is known on groundwater contamination by synthetic organic chemicals.

Is pesticide runoff from nonpoint sources polluting ground and surface water supplies?

In 1990, nearly 800,000 tons of nitrogen fertilizer, 200,000 tons of phosphorus fertilizer, and 100,000 tons of potassium fertilizer were sold in Texas (See Figure 1). In contrast, only 14,000 tons of pesticide were sold.

A report by the Texas Department of Agriculture (Aurelius, 1989) showed that nine pesticides were detected in samples from 10 of the 188 wells that were tested during 1987 and 1988. However, most of the detections were below maximum contaminant levels (MCLs) and did not pose sign)ficant health risks. Some pesticides were not detected in follow-up studies. Many of the problems stemmed from point source contamination of wells and wellhead areas.

Groundwater quality testing was also conducted in the Ogallala Aquifer by the High Plains Underground Water Conservation District No. 1 in 1987. Results showed that only 14 of 575 samples that were tested showed trace amounts of six pesticides (High Plains District, 1988). When followup tests were conducted 1988, these pesticides could no longer be detected. Other tests showed that nitrate levels were below EPA drinking water standards.

Routine application of pesticides and fertilizers to agricultural croplands does not have to produce nonpoint source pollution. A survey of pesticide and fertilizer use in the Trinity River watershed was recently conducted by Texas AgricuHural Extension Service (TAEX) specialists (Harris, 1990). Results show that many crops consume more nitrogen than is typically applied, leaving little excess nutrients to run off or seep into groundwaters.

There are few examples of pesticide runoff that can be linked to normal agriculture use in Texas. The Sabine River Authority reported that runoff of arsenic based defoliants is flowing into lakes and rivers in its watersheds. Sampling of the Lower Rio Grande and the Upper Trinity rivers and of Austin's Town Lake has detected pesticides that have either not been used for many years (chlordane and DDT) or pesticides that could be used for both urban and agricultural purposes. Pesticide runoff has been noted from rice producing areas, but usually only when aufficient detention time has not been provided due to storms. These results suggest that Texas farmers are not overfertilizing as is the case in several Midwest states.

Statewide TAEX data suggest that nitrate is not causing sign)ficant groundwater pollution problems in Texas (Unruh, 1990). For example, 63% of all soil nitrate levels tested were less than 5 parts per million (ppm), while nitrate concentrations of more than 20 ppm make up only 8% of the total (see Figure 2). In addition, morethan half of the high nitrate levels were found within a foot of the soil surface where they pose the least threat to groundwater contamination. Routine nitrogen applications may not produce excess nitrogen in soils. TAEX studies suggest that cotton, hay, and wheat remove the most nitrogen per unit of crop produced. West and Central Texas are the areas where the most nitrogen is being removed per the unit of nitrogen applied.

Pollution can still occur when excess nutrients and pesticides are applied (typically when nutrient budgets are not followed) or when droughts or floods impede crop growth and limit the amount of nitrogen and phosphorus crops can remove.

Studies by the USDA Agricultural Research Service have shown that erosion in the Texas High Plains can be three to five times greater from cultivated watersheds than from uncultivated rangelands (Jones, et ai, 1985). That study also pointed out the impact of severe storms and notes that less than 1 % of the storms produce up to 40% of the runoff.

Erosion from agricultural lands has been class)fied as a "major" land management problem on more than 24 million acres of crop and pasture lands (See Figure 3). Total annual erosion has been estimated at 1.94 tons per acre (Texas State Soil and Water Conservation Board, 1990). Rangeland accounts for most of Texas' erosion from agricultural lands (55%), followed by croplands (30%).

Farmer participation in the Federal Conservation Reserve Program may significantly reduce erosion. The program encourages producers to not cultivate soils that are highly vulnerable to wind and water erosion. So far, Texas farmers have placed roughly 3.9 million acres in the program.

Research and Education

Universities are now working with State and Federal agencies to learn more about nonpoint source pollution problems and ways to correct them.

The Texas Groundwater Protection Committee is made up of representatives from the TWC, the Texas Water Development Board, the Texas Department of Health, the Texas State Soil and Water Conservation Board (TSSWCB), the Texas Railroad Commission, TAEX, and the Texas Department of Agriculture. The Agricultural Chemicals Subcommittee is considering ways to lessen nonpoint source pollution risks without limiting the use of chemicals that agricultural producers need. Ideas being considered include banning the use of some chemicals in critical areas or during given months, reducing allowable use rates, and developing efficient methods to apply chemicals.

TAEX specialists are working with the TSSWCB, the USDA Soil Conservation Service (SCS), and other agencies in demonstration projects as part of the U.S.D.A. Hydrologic Unit Program. The goal is to encourage the adoption of BMPs that improve water quality. In the Seco Creek Project, TAEX specialists are assessing the impact of agricultural and brush control activities on the water quality in the Edwards Aquifer and nearby streams. Other Hydrologic Unit projects in :lude curbing pollution from dairy and pouHry operations that runs off into Lake Fork Creek, and lowering high nitrate levels in the Seymour Aquifer that may be related to agricultural operations.

Expansion of large dairies in central Texas is causing a sign)ficant pollution problem. The dairies confine large numbers of cows to small areas, and it's estimated that as much as 35 million pounds of manure is generated each week in Erath County. Because the TWC has a no discharge policy for dairy wastes, manure and effluents are collected and disposed of on lands where grasses and forage crops are grown. Heavy rains can flush nitrogen, bacteria, and other pollutants into streams that feed the Upper North Bosque River. Pollutants can also be leached from manure holding ponds and fields into porous aquifers.

Activities are now under way to improve water quality in the area. TWRI is sponsoring a project by John Sweeten and Mary Leigh WoHe of the Agricultural Engineering Department at Texas A&M University to monitor the quality and quantity of liquid and solid wastes being generated by area dairies and to estimate their impact on water quality. Technologies and BMPs that could lessen the risk of nonpoint source pollution are being developed. Treatment techniques include the use of two-stage lagoons that can cut volatile solids and chemical oxygen demand by more than 85% and settling basins that reduce volatile solids by 45%. BMPs include matching wastewater irrigation rates to crop needs and recycling to conserve water (Sweeten, et al., 1990). The area is also the focus of a TAEXI USDA Hydrokogic Unit project study. TAEX specialists are selecting BMPs that will reduce runoff from dairies, malfunctioning septic tanks, and runoff and infiltration of agricultural chemicals.

Wolfe is also working on two other nonpoint source pollution projects. One effort developed a Geographic Information System (GIS) that combines information on aquifer systems, cropped areas, and fertilizer use to assess the groundwater pollution potential posed by nitrate. Results show that roughly a third of outcrop areas for major aquifers (where aquifers are exposed to the surface) have a high pollution potential (Halliday and Wolfe, 1990).

Wolfe is also working with Tom Thurow of the Texas A&M University Range Science Department to assess whether vegetative buffer strips can reduce pollutants transported in urban runoff. The study is cosponsored by TWRI and the City of Austin. Planting dense vegetation near waterways can improve water quality by settling out pollutantsto before reaching streams. This project is measuring the amount of pollution reduction that occurs when bunch and sod grasses and oaks are utilized on slopes of 5% to 25% in field plots in Austin. Surface water runoff data is being gathered. Results may lead to better standards for vegetative fiHers in rural and urban areas.

Scientists with TAES at Temple including Ray Griggs and Allan Jones are evaluating and refining computer simulation models that assess the likelihood for spedfic agricultural chemicals to pollute groundwater based on soil types, farming practices, and other information. Researchers are also monitoring surface waters and soil samples for pesticide residues.

Studies by Ken Morgan and Leo Newland of the Environmental Studies Program at Texas Christian University (TCU) examined the impact of septic tanks and agricultural activities on nonpoint source pollution flowing to Lake Weatherford (Hayes, et al., 1990). Results suggest that agricultural chemicals comprise a major nonpoint source pollution problem because as much as 75% of them are applied in the spring when heavy rains occur. Additionally, 4,500 persons living near the lake's shoreline contribute an average of 267 pounds of organic chemicals and 50 pounds of nitrogen and phosphorus into the lake each day from septic tank discharges.

A TCU study by Ray Drenner and Kyle Hoagland of the Biology Department evaluated the impact of agricultural chemical runoff on fish communities in lakes. Their results suggest that runoff of pyrethroid insecticides like befenthrin can result in sign)ficant pollution problems in lakes by reducing zooplankton communities.

Forest management strategies can also impact the amount of erosion that results from those activities. Studies by Wilbert Blackburn, formerly of the Texas A&M University Range Science Department, assessed the amount of erosion caused by clear-cutting and associated activities. Results (DeHaven, et al, 1984) show that stormflows were greatest on the sites that were the most disturbed. Sediment losses were 10 times higher for areas that were sheared than for those that were chopped.

Pollution Prevention

Many things can be done now to reduce agricultural nonpoint source pollution.

The TSSWCB is engaged in many activities to reduce nonpoint source pollution.

For example, the TSSWCB offers technical assistance to farmers on agricultural management strategies that prevent pollution by preserving natural resources. Examples include encouraging the use of terraces, crop rotations that leave vegetation on otherwise bare soils, and reduced tillage systems. The TSSWCB is now developing a GIS to better understand nonpoint source pollution problems. The GIS will include data on land uses, soils, the amount and types of agrichemical use, levels of soil nitrate and other chemicals, and erosion and sedimentation rates. The GIS could be especially useful in identifying areas with severe nonpoint source pollution problems, measuring trends in pollutant loadings, and screening activities that may be impairing water quality.

A new report by the TSSWCB (1991) shows the areas where erosion from crop and range lands is a sign)ficant problem, (See Figure 2). It also analyzes nitrate and pesticide nonpoint source pollution of ground and surface waters that may be resulting from agricultural activities.

Specific BMPs that farmers can use to reduce nonpoint source pollution risks include conservation tillage, contouring, planting cover crops, strip cropping, terracing, increased application efficiency, integrated pest management, and regular soil testing (See Table 2).

Pesticide and fertilizer application effidency can be increased. The Low Energy Precision Application irrigation system can be utilized to efficiently apply pesticides. Insects can be controlled when only 6% of the labelled amount of pesticide is applied (Lyle and Bordovsky, 1989). New pesticides are being developed that are less toxic, less persistent, and less mobile.

Integrated pest management (IPM) programs take advantage of natural predators and environment factors to control insect populations. This lessees the use of pesticides and reduces pollution risks. IPM systems used in cotton production, for example, emphasize delaying when cotton is planted and using short-season varieties that make it nearly impossible for boll weevils to feed and reproduce (Frisbie, 1989).

The best way to lessen the risks of nonpoint source pollution is to annually conduct soil tests and develop nutrient budgets to determine the amounts of nitrogen and phosphorus crops actually need (Onken, 1990). If too little nutrients are applied, crop yields will suffer. On the other hand, excess application of nutrients may cause environmental damage. Steps in developing crop budgets include soil testing of nutrient levels, determining the amount of nutrients individual crops require for given yield goals, and analyzing the costs and benefits of varying nutrient levels. Split applications and use of slow-release nitrogen fertilizers can lessen the risks of runoff pollution.

Precautions can be taken to lessen nonpoint source pollution from livestock operations including locating feeding facilities away from streams and drainage channels, diverting and collecting runoff, and installing runoff holding ponds (Sweeten and Melvin, 1985). Safe disposal practices involve matching crop water and nutrient requirement to the amount of manure and effluents applied during the year.

Summary

Nonpoint source pollution is a serious water quality problem for Texas. As the ability to treat point sources of contaminants improves, nonpoint sources will become more obvious. Ways of controlling nonpoint sources of agricultural pollution are known and are being implemented both by voluntary means and by local ordinances and regulations. Helping agricultural producers become more efficient may be the best way to improve water quality.

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