ALABAMA A&M AND AUBURN UNIVERSITIES

Nonpoint Source (NPS) Pollution Of Alabama Waters

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If you live in Alabama, the beautiful and abundant waters of this state touch your life whether you enjoy fishing, boating, or just relaxing on the shore of a tranquil lake. If you farm, you depend on plentiful rainfall and sometimes supplemental irrigation to produce your crops. Whatever you do, you rely on clean water for drinking and for household use.

Most water supplies in Alabama are of good quality, but some have natural problems and some are polluted. This pollution may come from point discharges or from what is commonly referred to as nonpoint source (NPS) pollution.

What Is Nonpoint Source Pollution?

When you think of water pollution, do you envision a vile, foul-smelling liquid which oozes from the end of a pipe into a body of water? This type of effluent is called **point source pollution** because it comes from a specific spot, such as an industrial or municipal sewage treatment plant pipe. Point source pollution is relatively easy to locate and control. In fact, guidelines for controlling this type of discharge have been implemented by federal law since 1972.

What may not come to mind but which cause equal harm to our waters are the contaminants from nonpoint sources which seep quietly into surface water and groundwater without fanfare or warning. Unlike point source pollution, this pollution is not easy to pinpoint and control. Natural processes, which human activities have speeded up or modified, cause much of this type of pollution.

An exact and concise definition of nonpoint pollution is nearly impossible. However, most of it is generally associated with stormwater runoff, which carries sediment, nutrients, toxins, and organic material into receiving waters. Under some circumstances, groundwater can become contaminated by water percolating down through the soil.

Nonpoint source pollution can be further described by the following:

• It occurs over an extensive area, usually traveling overland before entering water.

• It is not easily monitored at the point of origin and the contaminants may not be traceable to their exact source.

• It flows intermittently.

• Its magnitude is related to certain uncontrollable climatic events.

What Factors Influence NPS Pollution?

Water quality may be affected by all upslope land use activities in a watershed. A watershed includes all land in a drainage system that contributes surface runoff to a given point, usually the lowest elevation outlet. All activities within a watershed may impact the quality of water flowing from this outlet.

Water does not recognize political boundaries. Thus, the physical boundary of a watershed, rather than arbitrary political boundaries, is commonly used for analyzing water quality problems.

The amount of NPS pollution in an individual watershed is extremely variable and depends on several factors: rainfall, vegetation, soil erodibility, topography, and human alteration of physical features.

Rainfall. The intensity and duration of rainfall is a major factor influencing runoff and NPS pollution in a watershed. A typical 30-minute thunderstorm in Alabama can dump more than 100 tons of water on an acre of land. Each raindrop strikes the ground at nearly 20 miles per hour. Surface runoff results when the rainfall rate exceeds the soil's capacity to absorb it.

Vegetation. Plant cover shields the ground surface from the full impact of falling rain and thus helps reduce erosion. When a raindrop falls on a leaf, the leaf absorbs the raindrop's energy. If the same drop falls directly on bare soil, it dislodges soil particles. Stems, leaves, and other plant litter also provide surface storage and slow overland flow. This allows more time for water to evaporate and infiltrate. Plant stems also allow more water to infiltrate into the soil by breaking the soil's crust. Plant roots improve internal soil structure, hold soil in place, and actively absorb water.

Soil Erodibility. The size, shape, and arrangement of soil particles as well as the organic matter content determine the soil's ability to absorb water and resist erosion. Coarse-textured sandy soils are loose and permeable and allow large volumes of water to move through them. Percolation is generally slower in fine-textured silty and clayey soils. Medium- to fine-textured soils, especially those lacking organic matter and good structure, are usually more subject to erosion.

Soil scientists have now determined a numerical value of erodibility for every soil mapped in the United States. Soil Conservation Service personnel use these values in calculating erosion rates under a variety of cropping systems and land-use patterns.

Topography. Topographic features such as drainage density, slope steepness, and slope length affect runoff and soil losses from erosion.

The drainage density of a watershed refers to the number of water channels present per unit of land area. Regions with steep terrain, such as northern Alabama, often have high drainage densities. In these areas, it is more likely that land-use activities will influence the quality of adjacent waterways.

Water will run down a steep slope faster than down a lower gradient slope of the same length. As water flows down longer slopes it accumulates and gathers more energy for dislodging and transporting soil particles. Because of their steep terrain, northern Alabama counties have the highest soil loss potential.

Actual soil loss can vary greatly depending on the land management practices employed. The largest erosion rates and the greatest sediment yields generally occur in watersheds that have the highest density of disturbed or bare soils. These watersheds are usually those with the most cropland. See Figure 1.

Human Alteration Of Physical Features. Modern technology has increased our ability to alter the landscape. Earth moving for construction, strip mining, and agriculture exposes millions of acres of soil to erosion. An individual watershed may include both urban and agricultural land uses. These different land uses may destroy vegetation, remove topsoil, or transform terrain features that are often undertaken with little consideration for how they affect water quality.

Nonpoint source pollution often occurs when land is disturbed without taking protective measures. The potential for such disturbance is extensive. In Alabama, there are approximately 4.5 million acres of cropland, and much of this land is tilled each year. At least one-third of this cropland is susceptible to high erosion rates. Nationally, approximately 4,000 acres per day of rural land are transformed by development to urban areas.

Source: ADEM Nonpoint Source Management Program, 1989.

Figure 1. Density of cropland in Alabama in acres of crops per square mile.

Land in transition between different uses is especially susceptible to stormwater runoff. Transitions occur in both urban and rural settings. The plowing of fields leaves soil, its accompanying nutrients, and organic matter vulnerable to the process of erosion. In harvesting mineral resources and raw materials such as timber, we disrupt the land—sometimes permanently. Rain washes nutrients and sediment off barren hills and deposits them in nearby rivers and lakes. Land may be left unprotected for several years while subdivisions are being developed. Erosion rates on such areas may be two hundred times greater than those on either rural lands or established residential areas.

In summary, surface runoff water is the primary means of transporting nonpoint source pollutants. The greater the volume of rushing water, the more pollutants it will contain. The contaminating materials can either be dissolved in the water or suspended as solids. One heavy rainstorm can sometimes do as

much damage in a matter of hours as an entire year of moderate rains will do.

What Are The Pollutants From Nonpoint Sources?

Various kinds of contaminants are carried into our water supply from urban and agricultural areas, disrupted forests, mining and construction sites, landfills, and septic tanks. Some NPS pollutants are more harmful than others. Some are potential public health hazards. Others are harmful primarily to fish and other aquatic organisms.

Major NPS pollutants include sediment, nutrients, toxic materials, and organic materials.

Sediment. A by-product of erosion, sediment is the nation's largest single water pollutant by weight or volume. The process of sedimentation fills streams, lakes, and harbors.

Sediment reduces water's capacity to sustain life. It clouds the water, reducing light penetration and, in turn, photosynthesis. More importantly, it alters bottom conditions, sometimes covering up suitable spawning sites and suffocating fish eggs and aquatic insects.

Soil particles are also the main carrier of other pollutants. Nutrients, organic matter, and potentially hazardous chemicals attach to sediment particles and are transported to surface waters.

Because sediment is Alabama's single largest water quality contaminant, areas with a high density of cropland have great potential to cause sediment damage to water quality. Alabama cropland density is given in Figure 1. Those areas with a larger percentage of land in crops have a high erosion potential. Other land features—such as topography, soil type, and land use—also influence erosion potential.

Nutrients. Although nutrients such as nitrogen and phosphorus are essential for aquatic plant growth, they cause problems when overly abundant in lakes and streams. The enrichment of lakes, and to a lesser extent streams, by plant nutrients is called **eutrophication.** Over a long period of time most lakes become choked with algae or weeds and evolve into bogs or marshes and ultimately become dry land. Human activities often increase the amount of nutrients reaching bodies of water and thereby speed up this aging process. Rapid aquatic plant growth and noxious algae blooms result from accelerated eutrophication.

Water clogged with weeds is undesirable for most recreational uses, such as swimming and boating. In addition when these weeds die and decompose, they consume oxygen in the water. Severe oxygen shortages may result in fish kills. Decaying algae and lake weeds also cause taste and odor problems.

To control aquatic plant growth, pollution abatement efforts often focus on reducing the amount of phosphorus from both point and nonpoint sources entering surface waters. Phosphorus is the plant nutrient which is usually least abundant naturally in fresh waters and often is the most significant factor limiting plant growth. When excessive phosphorus enters water, it can trigger the rapid growth of algae and aquatic weeds.

Nitrogen, occurring as nitrate, is a public health concern in groundwater supplies used for drinking. Nitrate may come from nonpoint sources such as nitrogen-containing fertilizers used in rural and urban settings, decomposing plant and animal wastes, and leaching of human waste products from failing or overloaded septic systems.

Higher than normal nitrate levels have been found in some shallow wells in Alabama. This condition appears to be most prevalent when nitrogen levels exceed plant or microbial needs and where soils and geologic conditions promote rapid infiltration and percolation of water from the surface.

Toxic Materials. Pesticides, industrial solvents, industrial chemical wastes, petroleum products, and heavy metals are washed into our waters daily. We do not know the long-term effects of low dosages of many of these substances. We do know, however, that high concentrations are very dangerous.

Pesticides, for example, can be transported by wind, rain, surface runoff, or groundwater leaching to lakes and streams. After entering water, pesticides may decompose to toxic or non-toxic substances or they may persist in their original forms. Aquatic organisms often concentrate these chemicals in their bodies well above the average concentration in the water. This is called **bioaccumulation.**

The original concern about pesticides was based on evidence which clearly showed that some chlorinated hydrocarbon chemicals persisted in the environment for more than 20 years. This gave them much more time to bioaccumulate in some organisms. This was the case with DDT. Although most of the so-called "hard" insecticides are no longer in use, some continue to affect water quality because of their persistence.

The danger of contamination from organic solvents, petroleum products, toxic metals, and industrial waste products has increased in waters adjacent to urban areas. Accidental spills and leaks from storage tanks and pipelines as well as leaching from disposal sites can cause severe water contamination problems. Metals of most concern in urban stormwater are lead, zinc, copper, chromium, cadmium, nickel, and mercury. Lead, zinc, and copper are the metals found most often.

Toxicity of metals to higher animals and humans is variable. For example, zinc, iron, and copper are considered to be the least toxic to humans. Mercury and cadmium, on the other hand, in very small doses may accumulate in people and cause liver damage or other problems. Lead, once a common paint pigment and component of several insecticides, affects human nervous, endocrine, reproductive, renal, and pulmonary systems. High levels of lead intake cause sterility, stillbirths, and abortions. In fact, there is so much concern for lead in drinking water today that the safety level was lowered in 1991. Concerns are increasing for rare industrial metals such as antimony, beryllium, and thallium.

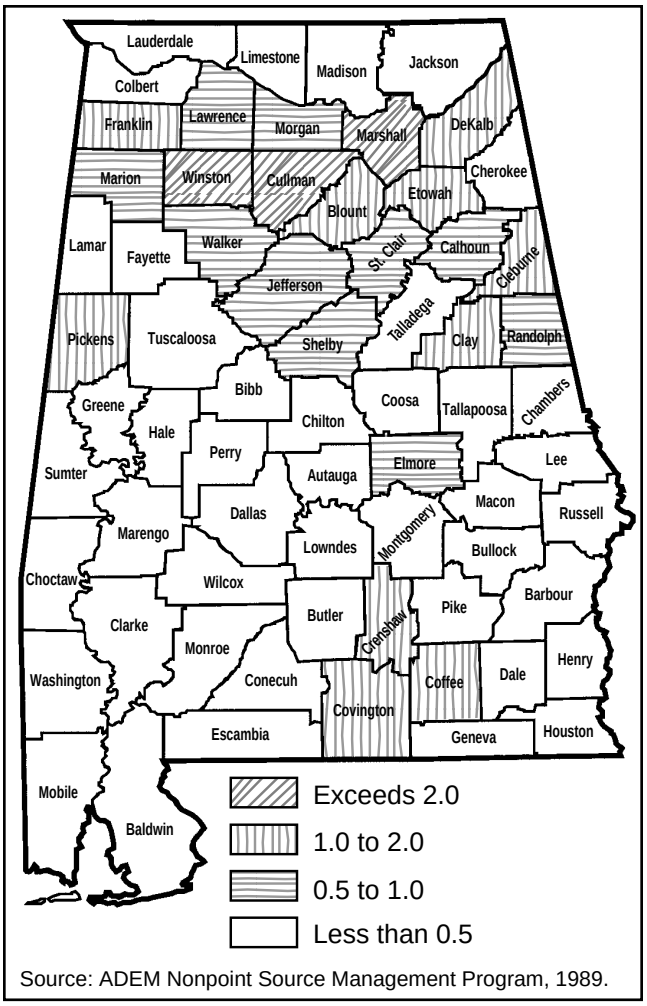
The presence of various metals also affects portions of the aquatic system. Marine brown algae, mollusks, crustaceans, mussels, and fishes accumulate various metals in their tissues. When these plants and animals are consumed, toxins can be passed along the food web and concentrated.

Organic Materials. Plant debris and animal wastes contribute nutrient and oxygen-demanding materials to our waters. Bacteria decompose organic materials and consume oxygen in the process. If the supply of organic materials is excessive, the oxygen supply may become seriously depleted. In general, the less dissolved oxygen in a lake or stream, the less capable the water is of supporting a variety of fish and aquatic life.

Potential disease-causing organisms may be delivered to surface water in runoff containing sewer overflows, septic tank wastes, and animal wastes. These organisms live in the intestines of humans and animals and some are bound to enter lakes and streams in runoff.

High bacterial levels have been traced to nonpoint pollution from both rural and urban sources. In some areas organic wastes in runoff are a more serious problem than wastes from municipal sewage treatment plants. Scientists now estimate that more than half of the organic matter entering the nation's surface waters comes from sources other than sewage treatment plants. Untreated human and animal waste contributes to this condition.

Animal waste is a high priority nonpoint source pollutant in Alabama. The Alabama Department of Environmental Management (ADEM) receives more water quality complaints associated with animal waste than any other agriculturally related nonpoint source pollutant. Although most animal waste is temporarily stored, in many cases it is ultimately applied to land resources. Areas with a high density of animals but low density of cropland and pastureland have the greatest potential for water quality problems. Alabama's livestock and poultry waste production per unit of cropland and pastureland is shown in Figure 2. Those areas with the highest ratio of animal wastes to available land resources are more likely to have excessive land application and subsequent water quality problems.



Source: ADEM Nonpoint Source Management Program, 1989.

Figure 2. Animal waste production in Alabama in tons per acre per year of cropland and pastureland.

What Can We Do About These Pollutants?

The complex nature of nonpoint pollution means that control programs will not be easy to establish or maintain. Controlling these contaminants will require solutions as diverse as the pollutants themselves.

Pollutants that create public health hazards are of prime importance. Pesticides, nitrates, and pathogen-containing wastes which fall into this category must be used or managed so as not to contaminate water supplies in the future.

Eutrophication, or accelerated nutrient enrichment, from nonpoint source runoff is a problem of national scope. Additional phosphorus in surface waters can be reduced by restricting the use of phosphate detergents, by properly managing fertilizer and animal

waste materials, and by controlling soil erosion and sedimentation.

In urban areas, solvents, petroleum products, heavy metals, or other toxic substances can concentrate in runoff waters. In many cases, sources of these contaminants and their precise impact on human health and the environment are not well understood. Communities may have to tackle nonpoint sources of pollution on a case-by-case basis and give some harmful pollutants priority over others.

Certain substances are more of a regional problem; thus, strategies will have to take regional differences and needs into consideration. Control programs, however, may have to be designed to correct the specific needs of individual cities.

Efforts like these should result in the significant improvement of rivers and some lakes and slow the degradation of others.

References

Alabama Department Of Environmental Management. 1989. Alabama Nonpoint Source Management Program. Montgomery, AL.

Daniel, T. C., and D. R. Keeney. 1978. Nonpoint Pollution: Causes And Consequences. G2956. Wisconsin Cooperative Extension Service. University of Wisconsin. Madison, WI.

Daniel, T. C., and Mary Forrest. 1978. Nonpoint Pollution: What Does It Mean For Wisconsin's Waters? G2962. Wisconsin Cooperative Extension Service. University of Wisconsin. Madison, WI.

Weinberg, Anne, Steve Berkowitz, and Fred Madison. 1979. Nonpoint Source Pollution: Land Use And Water Quality. G3025. Wisconsin Cooperative Extension Service. University of Wisconsin. Madison, WI.

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