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Dear Reader:

Water is one of the most essential and useful resources we have. It is necessary for many purposes, including sustaining life itself.

It is accepted fact that the amount of water is finite and that the distribution varies around the world. This is certainly true in Texas, where the high plains of the western part of the state are short of water while the coastal and eastern portions have more rainfall and more water.

No part of the state, however, has so much that we can afford to waste this precious resource.

The activities of man may pose a threat to water quality in many ways. We use water for drinking, for industrial purposes, to grow food and fiber, for recreation, and to carry off our wastes. We have learned that it is prudent to clean up the water after use so that it can later be used again.

We are also aware that there can be secondary effects on water quality from activities that do not directly use water: activities such as mining, including lignite; range management and forest practices.

It is important to the continued health of citizens of the state, as well as to continued growth, that we not only protect the existing quality of our waters, but also that we explore through research new techniques to manage this vital resource.

Dick Whittington, P. E.
Regional Administrator
Environmental Protection Agency
Region 6

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Editor: Lou Ellen Ruesink

Designer: Karen Glenn

For further information on research presented in this issue, contact **Water Currents,** Texas Water Resources Institute, College Station, TX 77843; send subscription requests and mailing changes to the same address.

Sediment in Texas Streams

Texas streams, when compared to those in many other states, are relatively free of harmful pollutants. Muddy rivers, though, are a natural fact of life in Texas. Particles of clay, silt, sand, or gravel carried by rainfall runoff into streams and reservoirs can impair water quality so that it is no longer usable.

Sediment, in fact, is the number one stream quality problem in the state today. Sediment reduces the storage capacity of reservoirs, levels streambeds causing streams to flood, adversely affects aquatic life, and increases municipal treatment costs.

Not only does sediment production, or soil erosion, harm surface water sources, but it removes the most fertile part of the soil, reducing land values and increasing production costs. Soil erosion also removes nitrogen, organics, and chemicals which are valuable to the land, but harmful to water resources.

Increasing pressures on Texas land for production and development require that land managers pay special attention to potential impacts on stream quality in the future.

Soil and water studies have been part of the overall program of The Texas Agricultural Experiment Station (TAES) since its inception in 1888. Many of these studies serve as a knowledge bank for the agricultural research agency's current efforts to reduce potential impacts of agricultural and forestry activities on Texas surface water sources. Projects featured in this issue of **Water Currents** include studies to determine the effects of livestock grazing on stream quality and to evaluate the impact of various timbering practices on stream quality.

Reducing Range Runoff

Nothing puts a smile on the face of a Texas range manager like a slow, soaking rain. A heavy gully washer, however, moves water across his land so fast that the runoff carries soil and nutrients with it. Worse yet, the soil and nutrients so valuable to the range manager are considered harmful water pollutants if they make their way into streams or reservoirs.

Because quality of runoff from rangelands directly affects the quality of water in the state's streams and reservoirs, keeping potential pollutants out of the water is a vital concern for this water-short state.

Rangeland is the largest single category of land use in Texas. Over 97 million acres - nearly 60 percent of the surface area of the state - is in rangeland. Rangeland includes natural grasslands, savannas, shrublands, deserts, coastal marshes, and wet meadows. These lands, because of climate or soil limitations, cannot grow cultivated crops or commercial forests on a sustained basis. Grazing animals is usually the most practical means of harvesting vegetation on them.

Range scientists associated with The Texas Agricultural Experiment Station have worked for decades to help range managers reduce water, soil, and nutrient loss from their land. TAES watershed specialists Wilbert Blackburn, Robert Knight, and Karl Wood have compiled a state-of-the-art report on grazing impacts on watersheds published in January 1982. Their comprehensive review of studies on the watershed impacts of grazing covers over 70 years of research and summarizes 130 projects conducted throughout the U.S.

Some of the earliest erosion problems in the West, according to the researchers, occurred on rangelands. Many of these problems resulted from the combined influence of improper stocking rate, poor distribution of animals, and the wrong kind or class of livestock. Unfortunately, accelerated erosion still occurs on many rangelands because of mismanagement of grazing animals.

Range managers, according to the watershed specialists in the Texas A&M University Department of Range Science, are concerned with runoff and soil loss aspects of range management practices. This interest is a re- direction from the managers' previous sole emphasis on livestock production. It is a result of increasing public concern about non-point sources of water pollution and potential shortages of water in the state to meet municipal, industrial, and agricultural needs. This new direction of range management, they add, also stems from the range managers' fear that federal regulation of water quality standards could impose unnecessary constraints on their range practices in the future.

Researchers predict that future demand for livestock products will increase substantially in the future and will require more intensive management of Texas rangelands. This will mean, they say, greater potential impact on stream quality.

The researchers emphasize that specific quantitative water quality data is lacking for most climates, soils, grazing systems, and range improvement practices in Texas. TAES research has filled in some knowledge gaps, however, and scientists are now able to propose some general range management guidelines to reduce water and soil loss from rangeland.

Several TAES research projects have analyzed the impact of various grazing systems on downstream quality. The research has been conducted primarily by researchers on the Texas A&M University campus and at the research station at Sonora.

Management for good quality water from rangeland is synonymous with good range management, according to TAES scientist Fred Smeins. One of the first range scientists in the nation to analyze and compare the quality of storm runoff from rangeland, Smeins says that practices which increase forage production tend to also improve runoff quality.

Smeins has compared rainfall runoff from pastures using different grazing systems developed by the superintendent of the Sonora research station, Leo Merrill. The systems involve removing livestock from an area periodically to allow rejuvenation of the vegetation.

Smeins collected and analyzed runoff from a pasture which had not been grazed by livestock for more than 30 years and compared this runoff with the quality of that from pastures using various grazing systems. He also sampled runoff from a continuously grazed pasture, by far the most prevalent type of grazing management in Texas. His results showed that continuously grazed pastures lose 30 to 60 percent more soil per year than pastures under a restrotation system or an ungrazed pasture.

He emphasizes that holding water and soil on the land will improve the vegetation cover and allow heavier grazing of the land while at the same time reduce the potential for downstream water pollution.

Smeins also directed an analysis of nitrates in range runoff. He found low nitrate concentration in most rainfall runoff except for heavy storms following long dry periods. Apparently some buildup of nitrate occurs when precipitation does not occur to either move the nitrate into the soil profile or carry it off in runoff water. Smeins found, however, that nitrogen in range runoff is negligible when compared to the nitrogen in runoff from cropland.

Since rain storms are few and far between on most Texas ranges, scientists often use an infiltrometer - a mobile rainfall simulator - to "make" rainfall in a specific location and at a specific intensity. TAES range scientist Blackburn has directed several studies using an infiltrometer to determine infiltration rates and sediment production.

One of his studies, in conjunction with TAES range scientists Knight and Merrill, looked at the impact of three grazing systems on infiltration rates and other soil characteristics. They found no significant difference between the moderately stocked, continuously grazed range and a range grazed with a rotation system. Infiltration rates for the heavily stocked range, however, were significantly lower than for the other two ranges.

Overgrazing, they found, adversely affects the ability of the soil to hold water in the following ways:

- Heavy trampling by livestock compacts the soil and makes it less receptive to water intake, thus increasing the potential for runoff and erosion.
- Removal of the protective plants and plant litter increases raindrop impact and lowers organic matter available for aggregating soil particles.
- Runoff moves more swiftly across overgrazed land and picks up more soil and nutrients on its way to the stream channel.

For more than 100 years, say TAES scientists, most of Texas rangelands have been managed improperly. They feel that not only does much of the Texas rangeland need to be rehabilitated to recover its productive capacity and improve its ability to hold soil and water, but it also must be carefully managed once these conditions are attained to maintain desirable conditions.

Recent studies by TAES range scientists have found that the range improvement practices developed by TAES research through the decades to increase livestock production can also reduce runoff and its adverse impacts downstream. The additional demands placed on food production in the state and the increased concerns in Texas for future water supplies make range management research and studies on hydrologic impacts of modern range practices vitally important today.

Stream Quality and Forest Management

A large portion of the state's usable surface water originates in the forests of East Texas. Forest streams - traditionally a source of high quality water - drain into seven of Texas' major river basins.

Rainfall in a mature forest either falls on the leaf canopy or in the litter layer on the forest floor. The water then infiltrates into the soil and travels to the stream channel via subsurface flow with little or no surface runoff.

As the demand for timber increases nationwide, however, the 24 million acres of East Texas forests are sure to be more intensively managed and harvested. Increased timbering activity will increase potential for damage to the quality of the streams draining the forests. Forest practices most likely to impact stream quality are poor road construction, careless harvesting, and improper site preparation before planting.

The most common harvesting procedure in East Texas is called clearcutting. As the name implies, clearcutting means harvesting every marketable tree in a certain area. The clearcutting process is similar to steps taken in crop production: trees are harvested, the ground is prepared for replanting, and new trees are planted. A major difference in crop acres and clearcut acres, however, is that within a one-year period, the ground cover on the forestland will be substantially regenerated and may not be disturbed again for 30 years or longer while cropland is generally harvested and replanted each year.

Close to 200,000 acres of East Texas forests are clearcut each year. Three-quarters of the clearcut areas receive some form of site preparation prior to replanting. Site preparation activities commonly used in East Texas can drastically alter a site and expose large areas of soil.

The combination of shearing and windrowing is the most popular site preparation technique today. The shearing and windrowing process involves cutting the vegetation left after trees are harvested, piling it into long stacks called windrows, then burning the windrows.

Roller chopping, the second most common site preparation in Texas, involves a crawler-tractor which first pushes over small trees and plants with a front blade, then nulls a large metal drum with protruding flanges to chop the vegetation. The drum, or chopper, not only breaks up the residue, but also helps disc and aerate the soil. With the chopper, the residue is left on the ground to help protect the soil. After the litter has dried, the tract is broadcast burned leaving residue to fertilize and promote the growth of new seedlings.

TAES watershed management researchers Wilbert Blackburn and Mark Dehaven recently completed a study of nine six-acre test plots in southern Cherokee County to compare the stream quality impact of shearing and windrowing with that of roller chopping.

Six test plots were clearcut during the summer of 1980 while three other plots were left undisturbed. Three of the harvested watersheds were site prepared by shearing with a V-blade, stacking the debris in windrows, then burning the windrows. The other harvested test plots were roller chopped and broadcast burned after harvesting. All site preparation took place during November of 1980.

The researchers measured the quantity and flow rate of stormflow runoff during 1980 and 1981. They also collected samples of runoff to analyze the sediment, turbidity, conductivity, nitrogen, phosphorus, and potassium.

They concluded in the three-year study completed in November 1982 that shearing and windrowing increase susceptibility to erosion by removing the protective surface cover and exposing the bare soil. The heavy shear and pile tractors compacted the soil, thus reducing infiltration and increasing surface runoff.

Roller chopping caused less increase in runoff because the debris left on the surface incorporated organic matter into the soil and because the roller chopper tilled the soil which increased infiltration. Runoff, according to the research, averaged 9, 5, and 1 percent of the precipitation falling on the sheared, chopped, and undisturbed watersheds, respectively.

Total nitrogen losses on the test plots were nearly 20 times greater from the sheared test plots than from the undisturbed watersheds and three times greater than from chopped watersheds. Losses of total phosphorus, potassium, magnesium, and sodium were also significantly greater from sheared watersheds than from chopped or undisturbed watersheds.

One year after site preparation the researchers found active erosion on 83 percent of the exposed mineral soils and 47 percent of the entire watershed on the sheared plots. In comparison, 35 percent of the exposed mineral soil on the chopped watershed showed evidence of erosion; only 5.6 percent of the total area was in some stage of erosion.

This research is just one of the ongoing TAES efforts to help guide future forest management decisions in order to reduce potential impact on East Texas stream quality.

Because geology, soils, topography, and climate are unique to Texas, says Blackburn, traditional management practices in other areas of the country are not necessarily best for East Texas forests. He lists several important characteristics in which Texas forests differ from those in other regions:

- Planting, growing, and harvesting cycles occur in comparatively short rotations of less than 35 years.
- Runoff is minimal because of the flat or gently sloping terrain.
- Stream temperatures are naturally warmer, and most Texas fish are less affected by changes in temperature or quality of streams than species in northern forest streams.
- Reforestation rates are rapid compared to those in colder climates.
- Road systems in East Texas forests are well-established because of previous timber harvests and because of hunting and oil and gas activities.
- Sediment and nutrients carried by East Texas rivers are important to the productivity of Gulf Coast bays and estuaries.

For these reasons, says the TAES researcher, it is important that Texas forest management practices be based on research findings specific to the state climate, soils, plants, and present management practices.

TAES researchers, including range scientists, forest scientists, and agricultural economists, have studied Texas forest management activities to determine their impact on stream quality and to evaluate their effectiveness to control potential impact on streams. The scientists found that most of the practices recommended to reduce the impact on stream quality are already common procedures in government-owned forests or on land managed by the forest industry.

They found, however, that control measures to reduce impact have not been adopted to any great extent by non-industry owners, the largest group of Texas forestland owners. Ownership of over 60 percent of all forestland in Texas is divided among land owners averaging less than 100 acres per owner. The forest industry owns 35 percent of the 11 million acres of commercial forest in Texas while the remaining 670 thousand acres is in national or state forests.

Whatever measures are taken to protect forest streams, Blackburn points out, will also benefit the forestland owner by reducing soil and nutrient loss, minimizing erosion problems, encouraging fish and wildlife, and increasing land values.

Ripples & Waves

More than a million acres in Texas will be stripmined in the next 40 to 50 years to recover the lignite deposits Iying beneath the land's surface. Soil and crop scientists associated with The Texas Agricultural Experiment Station have studied the potential impacts of this activity since 1974.

Soil scientist Lloyd Hossner recently compiled a summary of TAES research on reclamation of stripmined areas. He included projects on improving soil properties and on restoring areas originally in native pasture to improved pastures. Another TAES study in the summary analyzed ways to restore sections of forests demolished by stripmining.

TAES researcher Kirk Brown compared the runoff water quality from reclaimed spoil material to that of existing surface soils on three potentially mineable geological deposits along the Texas Gulf Coast.

Ongoing research continues to evaluate the geology, soils, climate, vegetation, and economics necessary to determine the impact of stripmining on water quality and the methods to restore the productivity of areas of Texas to be stripmined in the next few decades.