SEDIMENT POLLUTION

TSM 424 Semester Project
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Sediment is defined as particles derived from soil or rock that have been, or are being, transported by water or wind. The erosion of land surfaces and stream banks produces sediment. Sediment pollution is a major problem in the United States. And sediment threatens water supplies and recreation, and causes harm to plant and fish communities.

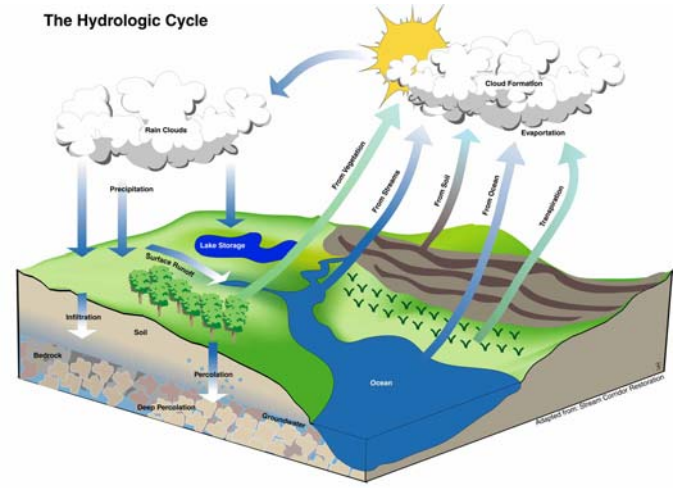
This bulletin reviews examples of agricultural practices that are the source or cause of the pollution, how the pollutant moves from source to water body, and at last provides three agricultural best management practices that can help to alleviate the water pollution problem as well as how it reduces transport of the pollutant from source to point of impact.

According to the USDA/NRCS, almost 27 billion dollars a year is lost in productivity on cropland and pastureland. And an additional $17 billion is estimated annually for off-site environmental costs, such as increased water treatment cost, due to erosion in the U.S.

Nature of Water Source that is Impacted

Hydrologic Cycle

The water cycle is the continuous movement of water over, above, and beneath the Earth's surface. It is powered by solar energy, and because it is a cycle, there is no beginning or end. Water moves from compartment to compartment, such as from river to ocean, by the physical processes of evaporation, precipitation, infiltration, runoff, and subsurface flow. Let's look at runoff process because it is closely related to the sediment movement.



<Figure 1> The hydrologic cycle

Runoff is the movement of surface water to the oceans, chiefly in the form of rivers, lakes, and streams. Runoff consists of precipitation that neither evaporates, transpires nor penetrates the surface to become groundwater. As it flows, the water may infiltrate into the ground, evaporate into the air, become stored in lakes or reservoirs, or be extracted for agricultural or other human uses.

A portion of runoff enters rivers in valleys in the landscape, with stream flow moving water towards the oceans. Runoff, and ground-water seepage, accumulate and are stored as freshwater in lakes. And this accumulated and stored sediment causes pollution to the water body due to the pollutants attached within the sediment. Not all runoff flows into rivers, though. Much of it soaks into the ground as infiltration. Some water infiltrates deep into the ground and replenishes aquifers, which store huge amounts of freshwater for long periods of time. Some infiltration stays close to the land surface and can seep back into surface-water bodies as ground-water discharge, and some ground water finds openings in the land surface and emerges as freshwater springs. Over time, though, all of this water keeps moving, some to reenter the ocean.

Reduced transport capacity (frequent flood)

Deposited sediment reduces the transport capacity of roadsides ditches, streams, rivers, and navigation channels. Decreases in capacity can result in more frequent flooding. Sediment can also reduce the storage capabilities of reservoirs and lakes.

<Photo 1> Deposited sediment in water channel

Turbidity affects aquatic life

Sediment affects the use of water in many ways. Suspended solids can significantly reduce or limit the sunlight penetrating into the water, which is required to aquatic plants and fishes. Turbidity interferes with the feeding habits of fishes, and it leads to reduce fish, coral, and plant populations. As a result, it decreases the overall productivity of lakes, streams, and coastal waters.

Pollutant that Cause the Concern

Chemicals such as some pesticides, phosphorus, and ammonium are transported with sediment in an adsorbed state, and chemical sediment forms as minerals crystallize and settle from water that contains lots of dissolved particles. In a particular situation, such as decreased oxygen concentrations in the overlaying waters or the development of anaerobic conditions in the bottom sediments, these chemical particles can be released from the sediment.
Phosphorus is one of the strongly adsorbed chemicals which have high K value that is expressed in terms of an adsorption coefficient, and it tends to move mostly with soil. This adsorbed phosphorus transported by the sediment may not be immediately available for aquatic plant growth but does serve as a long-term contributor to eutrophication.

Causes of Sediment Pollution

Sediment pollution is a major problem in the United States. This is caused by a number of factors. The factors included in the Universal Soil Loss Equation give you a good idea of causes of the pollution. These factors include, but are not limited to rainfall factor, soil erodibility factor, slope factor, crop factor, and supporting conservation practices. Only one of these factors, the rainfall factor, is hard to control but the rest can be controlled.

Improper agricultural practices are a main source of soil erosion. Farming on steep slopes, heavy tillage, and lack of supporting conservation practices are the reasons why there is a great deal of soil erosion. The soil erodibility factor and crop factor are related in the fact that they both can be reduce by what the farmer does to his/her land. The soil erodibility factor will decrease as organic matter decrease and the crop factor is related to tillage and residue management. So if the farmer doesn't increase the organic content on his land then you can expect more soil loss. Depending on which tillage practice is used can affect crop residue and soil loss.


<Photo 2> Steep slope farming

There are three main types of tillage: conservation tillage, reduce tillage, and conventional tillage. Conservation tillage, which is the best, leaves more plant residue on the soil surface where conventional tillage is the worst leaving little plant residue. The importance of having plant residue is that it reduces soil loss in the form of sheet and rill erosion.

This however creates another problem for farmers. A certain amount of tillage is needed for weed and pest management, incorporation of chemicals, and leveling of the field for planting. Another factor that can be control is the slope factor. The steeper the slope that is being planted the more of a risk for soil loss. So ideally you would want to plant crops on land having high organic content, little to no slope, and have a conservational tillage practice. However, in the real world this is very rarely the case. This is where supporting conservation practices play an important role.

The risk of soil loss in greatly increased when the farmer doesn't use any conservation practices. These can be in the form of planting all the way to the stream or lake edge. Planting on steep slopes increasing the slope factor, which increase soil loss. So in a real situation all factors need to be account for. If heavy tillage or planting on a steep slope in unavoidable then

supporting conservation practices need to make up for these situations.

Pollutant Movement

Sediment is the result of erosion. It is being transported from the source to the water body by wind, water, gravity, or ice. Eroded soil is transported from the field in runoff or by wind, and as eroded soil moves from its original site, pollutants attached to the soil particles also move along with it.

Sediment particles are classified by size, with smallest being clay and the largest being boulders. Smaller or fine particles are usually carried in suspension while the larger materials are moved along the channel bottom by rolling, sliding, or bouncing. Fine particles are the most chemically active part of soil and carry more adsorbed nutrients than larger particles, because small particles have much greater adsorption than large particles. Most deposited sediment contains a higher proportion of fine particles (silt, clay, organic matter) than the parent soil from which it was derived. So it generally contains higher concentration of phosphorus and pesticides.

Chemicals such as some pesticides, phosphorus, and ammonium are transported with sediment in an adsorbed state. Changes in the aquatic environment, such as decreased oxygen concentrations in the overlying waters or the development of anaerobic conditions in the bottom sediments, can cause these chemicals to be released from the sediment. Adsorbed phosphorus transported by the sediment may not be immediately available for aquatic plant growth but does serve as a long-term contributor to eutrophication.

Sediments from different sources vary in the kinds and amounts of pollutants that are adsorbed to the particles. For example, sheet, rill, ephemeral gully, and wind erosion mainly move soil particles from the surface or plow layer of the soil. Sediment that originates from surface soil has a higher pollution potential than that from subsurface soils. The topsoil of a field is usually richer in nutrients and other chemicals because of past fertilizer and pesticide applications, as well as nutrient cycling and biological activity. Topsoil is also more likely to have a greater percentage of organic matter. Sediment from gullies and stream banks usually carries less adsorbed pollutants than sediment from surface soils.

Many forms of phosphorus attach to soil particles rather than dissolve. A large portion of the phosphorus is transported to streams through sediment transport, due to its higher adsorption coefficient.

Best Management Practices

There are many conservation practices that can reduce soil loss. However we will focus on different types of buffer strips between fields and water bodies. The ones that will be discussed are filter strips, riparian forest buffers, and grassed waterways.

Filter Strips

A filter strip is simply an area of vegetation for removing sediment, organic matter, and other pollutants from runoff and wastewater. There are three main areas where this practice applies (1) on cropland at the lower edge of the field adjacent to water bodies (2) areas requiring filter strips as part of a waste management system (3) on forestland where filter strips are needed as part of a forestry operation to reduce sediment delivery to water bodies. The filter strip flow length shall be determined based on field slope percent and length, and filter strip slope percent. The width of the filter strip shall follow the following table 1.

	0.5	1	2	3	4	5
Warm Season - Min	20	25	35	45	55	60
Cool Season - Min	40	50	70	90	110	120

<Table 1> Land slope at the buffer site (%)

The filter strip should be planted with tall, stiff stemmed grasses. Legumes and forbs shall not exceed 50 percent of the mixture.

Riparian Forest Buffer

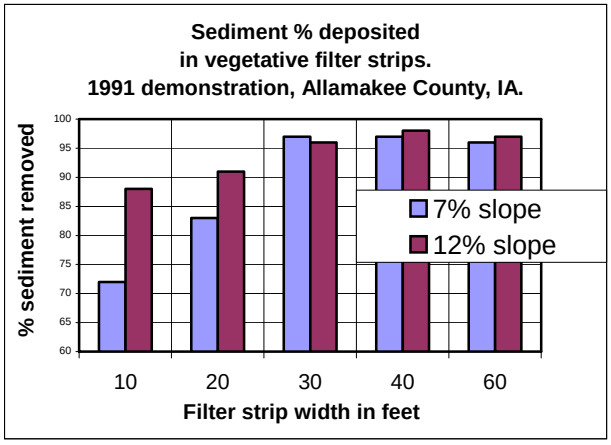
A riparian forest buffer is an area of trees and/or shrubs and grasses located adjacent to and up gradient from streams or water bodies to reduce excess amount of sediment. This practice applies to areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands, sinkholes, tile inlets, agricultural drainage wells and other areas with ground water recharge. This buffer consists of two zones. Zone 1 is a tree/shrub zone that begins at the upper edge of the active channel or shore and extends a minimum distance of 40 feet. Vegetation in this zone will consist of two rows of trees or shrubs. Vegetation for this zone can consist of perennial ryegrass, orchardgrass, timothy, red clover, alsike clover, and ladino clover. Zone 1 must comprise at least one third of the total width of the riparian forest buffer.

Zone 2 will begin where Zone 1 ends and extend a minimum of 20 feet perpendicular to Zone 1. This zone will consist of stiff stemmed grasses suited to the site. Native warm season grasses are preferred. Zone 2 shall meet the minimum width requirement in table 1. At least one third of the total buffer area must be trees and/or shrubs.

Grassed Waterways

A grassed waterway is a natural or constructed channel that is shaped or graded to required dimensions and established in suitable vegetation for the stable conveyance of runoff. The purpose of a grassed waterway is to convey runoff from terraces, diversions, or other water concentrations without causing erosion of flooding. This practice applies where added capacity, vegetative protection, or both are required to control erosion resulting from concentrated runoff and where such control can be achieved by using this practice alone or combined with other conservation practices. The waterway needs to be constructed and planted before any other channels of structures are allowed to discharge into it. Once the channel is seeded it needs to be protected by hay or straw until it can establish itself. Suggested vegetation include weeping lovegrass, reed canarygrass, and native grass mixtures

These are just a few of the conservation practices that can reduce sediment pollution. According Figure 2 a study done by Schultz et al (1992) found that vegetative filter strips can remove up to 95% of eroded sediment. For more information on these practices and other practices contact your local NRCS office.



<Figure 2> Measured soil erosion rates from 60-foot wide fallow strips above vegetative filter strips were 13 tons per acre for the 7% and 29 tons per acre for the 12% slope. Source: Schultz, et al., 1992.