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Resource Concerns

SOIL

Sheet, Rill and Wind Erosion

Soil Erosion - Sheet, Rill and Wind Erosion

Detachment and transportation of soil particles caused by rainfall runoff/splash, irrigation runoff, or wind that degrades soil quality.

What is it?

Wind or water erosion is the physical wearing of the earth's surface. Erosion is not always readily visible, even when soil loss exceeds unsustainable levels. Symptoms of soil erosion by water may be identified by small rills and channels on the soil surface, soil deposited at the base of slopes, sediment in streams, lakes, and reservoirs, and pedestals of soil supporting pebbles and plant material. Water erosion is most obvious on steep, convex landscape positions. Symptoms of wind erosion may be identified by dust clouds, soil accumulation along fence lines or snowbanks, and a drifted appearance of the soil surface.

Why is it important?

Erosion removes surface soil material (topsoil), reduces levels of soil organic matter, and contributes to the breakdown of soil structure. This creates a less favorable environment for plant growth. Loss of only 1/32 of an inch can represent a 5 ton/acre soil loss. In soils that have restrictions to root growth, erosion decreases rooting depth, which decreases the amount of water, air, and nutrients available to plants. Erosion removes surface soil, which often has the highest biological activity and greatest amount of soil organic matter. Nutrients removed by erosion are no longer available to support plant growth on-site, and when they accumulate in water, algal blooms, lake eutrophication, and high dissolved oxygen levels can occur. Deposition of eroded materials can obstruct roadways and fill drainage channels. Blowing dust can affect human health and create public safety hazards.

What can be done about it?

Soil erosion can be avoided by maintaining a protective cover on the soil and modifying the landscape to control runoff amounts and rates. To avoid water erosion, include high residue, perennial, and sod crops in the cropping system, grow cover crops, manage crop residues, and shorten the length and steepness of slopes. To avoid wind erosion, keep soil covered with plants or residue, plant windbreaks, use stripcropping, increase surface roughness, cultivate on the contour, and maintain soil aggregates at a size less likely to be carried by wind.

Sheet, Rill and Wind Erosion at a Glance

Problems / Indicators - Changes in soil horizon thickness, soil deposition in fields and water, and decreased organic matter	
Causes	Solutions
• Bare or unprotected soil • Long and steep slopes • Intense rainfall or irrigation events when residue cover is at a minimum • Decreased infiltration by compaction	• Residue management • Crop rotations • Cover crops • Terraces • Contour farming • Stripcropping • Windbreaks • Herbaceous wind barrier

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Resource Concerns

SOIL

Concentrated Flow Erosion

Soil Erosion - Concentrated Flow Erosion

Untreated classic gullies may enlarge progressively by head cutting and/or lateral widening. Ephemeral gullies occur in the same flow area and are obscured by tillage. This includes concentrated flow erosion caused by runoff from rainfall, snowmelt, or irrigation water.

What is it?

Ephemeral and classic gully are forms of erosion created by the concentrated flow of water. They are easily identified through visual observation. An ephemeral cropland gully is larger than a rill and smaller than a classic gully. They usually result from the junction of rills that form a dendritic (branching or tree-like) pattern of channels. Ephemeral gullies usually appear on cultivated fields during the planting or growing season, but are temporarily removed by cultivation. Ephemeral gullies can reappear at or near the same location on a yearly basis because the surface topography of the field does not change appreciably. Classic gully erosion generally occurs in well defined drainage ways and generally is not obliterated by tillage. In some situations, headcuts are present and aid in advancing the gully upstream.

Why is it important?

Concentrated flow erosion removes surface soil, which often has the highest biological activity and most soil organic matter. Nutrients removed by erosion are no longer available to support plant growth on-site, and when they accumulate in water, algal blooms, lake eutrophication, and high dissolved oxygen levels can occur. Deposition of eroded materials can obstruct roadways and fill drainage channels. Gullies can impact farm operations by creating barriers that change traffic patterns and create hazards that can damage farm equipment.

What can be done about it?

Ephemeral erosion can be controlled using a conservation cropping system that includes residue management. High residue crops and maintaining soil cover throughout the year are effective means for controlling ephemeral erosion and aid in the control of classic gully erosion. Gully formations can be difficult to control if remedial measures are not designed and properly constructed. Correcting concentrated flow erosion involves mitigating the damage and addressing the cause. The cause of increased water flow across the landscape must be considered and the corrective action usually requires a system of conservation practices. Conservation tillage and cropping practices that increase water infiltration into the soil result in less runoff and protect land from erosion.

Concentrated Flow Erosion at a Glance

Problems / Indicators - Branching or tree-like pattern of rills, gullies, headcuts	
Causes	**Solutions**
• Bare or unprotected soil • Excess runoff • Inadequate outlet for water	• Residue management • Cover crops • Terraces and/or grassed waterways • Grade stabilization structure • Lined waterway or outlet • Water and sediment control basin

March 2012

Shoreline, Bank and Channel Erosion

Soil Erosion - Shoreline, Bank and Channel Erosion

Sediment from banks, shorelines or conveyance channels threatens to degrade water quality and limit use for intended purposes.

What is it?

Stream stability is an active process, and while streambank erosion is a natural part of this process, it is often accelerated by altering the stream system. Streambank erosion is that part of channel erosion in which material is eroded from the streambank and deposited at the base of the slope or in the channel. Streambank erosion is usually associated with erosion of the streambed. It occurs along perennial, intermittent, and ephemeral streams.

Why is it important?

The benefits of proper streambank stabilization go far beyond preventing loss of land and keeping sediment out of streams. Streambank erosion increases sediment in the stream degrading water quality and resulting in the loss of fertile bottomland. The quality of wildlife habitat is impacted both on land and in the stream. Streambank erosion increases the stream's sediment load and changes its shape and function. When this happens the stream loses its ability to transport sediment which causes it to become wide and shallow. The stream channel can become braided, quality habitat is lost and the increased sediment can reduce overall biological productivity.

What can be done about it?

Determining the cause of accelerated streambank erosion is the first step in solving the problem. Development in the watershed often alters the stream equilibrium by changing rainfall-runoff relationships. Many of the traditional methods of dealing with streambank erosion, such as rock revetments, are expensive to install and maintain. While hard solutions are often needed to protect infrastructure, these treatments may solve the problem at the expense of habitat and stream corridor aesthetics. There are some promising developments in the area of streambank stabilization and stream restoration. Greener and more natural treatment alternatives are being more widely adopted. Soil bioengineering practices, native material revetments, combinations of rock and vegetation, and in-stream structures help to stabilize eroding banks. These techniques can be used to move a stream toward a healthy, stable and self-maintaining system.

Shoreline, Bank and Channel Erosion at a Glance

Problems / Indicators - Eroding Banks, degrading streambed, and manipulated stream channels	
Causes	Solutions
• Increased runoff due to land use changes in the watershed • Eroding or unstable streambanks • Exposed tree roots along banks • Large runoff events • Degraded riparian areas • Uncontrolled livestock access	• Bank armor and protection • Soil bioengineering practices • In-stream structures • Native material revetments • Riparian areas with native or locally adapted vegetation • Control livestock access to the water bodies

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Resource Concerns

SOIL
Subsidence

Soil

- Soil Erosion
- Soil Quality Degradation
  - Subsidence
  - Compaction
  - Organic Matter
  - Salts and Chemicals

Water

Air

Plants

Animals

Energy

Soil Quality Degradation - Subsidence

Loss of volume and depth of organic soils due to oxidation caused by above normal microbial activity resulting from excessive water drainage, soil disturbance, or extended drought. This excludes karst / sinkholes issues or depressions caused by underground activities.

What is it?

Subsidence is a gradual lowering of the surface elevation of an organic soil, or a reduction in the thickness of organic matter. Organic soils (Histosols) are those that are predominantly organic soil materials. They are commonly called bogs, moors, or peats and mucks. The most important cause of organic soil subsidence is a process commonly termed "oxidation." A high water table creates anaerobic conditions that slow the breakdown of organic materials. The balance between accumulation and decomposition of organic material shifts dramatically when soil is drained. Oxidation under aerobic conditions converts the organic carbon in the plant tissue to carbon dioxide gas and water. Aerobic decomposition under drained conditions is much more efficient thereby causing the loss of organic matter.

Why is it important?

Soil subsidence is usually irreversible. The natural rate of accumulation of organic soil is on the order of a few inches per 100 years; the rate of loss of drained organic soil can be 100 times greater, up to a few inches per year in extreme cases. Thus, deposits that have accumulated over hundreds of years can disappear relatively quickly in response to human activity. In time, the remaining organic material becomes diluted through the incorporation of the organic layer into the mineral subsoil. This reduces the productivity of the soil.

What can be done about it?

Once oxidation depletes the organic matter, it generally cannot be restored. The oxidation rate of organic matter can be minimized by managing water table levels to reduce aeration. In non-crop situations, keep the water table as close to the soil surface as possible. During the cropping season, maintain the water table at the optimum level for the crop being grown. Use cover crops to keep the soil covered and to return organic matter to the soil.

Subsidence at a Glance

Problems / Indicators - Loss of volume and depth of organic soils	
Causes	Solutions
• Drainage • Cultivation / Soil disturbance	• Water table management • Diverse, high biomass crop rotations • Cover crops • Conservation tillage • Perennials in rotations

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Resource Concerns

SOIL
Compaction

Soil Quality Degradation - Compaction

Management induced soil compaction resulting in decreased rooting depth that reduces plant growth, animal habitat and soil biological activity.

What is it?

Compaction occurs when soil particles are pressed together, reducing pore space between the particles and pushing out the air normally located there. It is manifested as an increase in bulk density. A severely compacted soil can become effectively impermeable. Soils are either naturally compacted (heavy, clay soil) or compaction is caused by management activities. Compaction is assessed using measurements of bulk density, penetration resistance, porosity, and root growth patterns.

Why is it important?

Compaction reflects the soil's ability to function for structural support, water and solute movement, and soil aeration. It may cause restrictions to root growth, and poor movement of air and water through the soil. Compaction can result in shallow plant rooting and poor plant growth, influencing crop yield and reducing vegetative cover available to protect soil from erosion. By reducing water infiltration into the soil, compaction can lead to increased runoff and erosion from sloping land or waterlogged soils in flatter areas. In general, some soil compaction to restrict water movement through the soil profile is beneficial under arid conditions, but under humid conditions compaction decreases yields.

What can be done about it?

Long-term solutions to soil compaction problems revolve around decreasing soil disturbance and increasing soil organic matter. A system that uses cover crops, crop residues, perennial sod, and/or reduced tillage results in increased soil organic matter, less disturbance and reduced bulk density. Additionally, the use of multi-crop systems involving plants with different rooting depths can help break up compacted soil layers. Grazing systems that minimize livestock traffic and loafing, provide protected heavy use areas, and adhere to recommended minimum grazing heights reduce bulk density by preventing compaction and providing soil cover.

Compaction at a Glance

Problems / Indicators - Bulk density, penetration resistance, porosity, root growth patterns	
Causes	**Solutions**
• Working wet soil	• Avoid working wet soil
• Excess traffic, machinery or livestock	• Reduce traffic/tillage operations, rotate
• Heavy machinery	• Controlled traffic patterns
• Repeated tillage at same depth	• Subsoil or rip compacted areas
• Poor aggregation	• Diversify cropping system
• Low organic matter	• Conservation tillage
	• Cover crops
	• Animal manures and compost
	• Non-compacting tillage

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SOIL
Organic Matter

Soil Quality Degradation - Organic Matter

Soil organic matter is not adequate to provide a suitable medium for plant growth, animal habitat, and soil biological activity.

What is it?

Soil organic matter is carbon-rich material that includes plant, animal, and microbial residue in various stages of decomposition. Live soil organisms and plant roots are part of the carbon pool in soil but are not considered soil organic matter until they die and begin to decay. The quantity and composition of soil organic matter vary significantly among major ecosystems. Soil in arid, semiarid, and hot, humid regions commonly has less organic matter than soil in other environments.

Why is it important?

Many soil properties impact soil quality/soil health, but organic matter deserves special attention. It affects several critical soil functions, can be manipulated by land management practices, and is important in most agricultural settings across the country. Because organic matter improves soil structure and enhances water and nutrient holding capacity, managing for soil carbon can enhance soil productivity and environmental quality, and it can reduce the severity and costs of natural phenomena, such as drought, flood, and disease. In addition, increasing soil organic matter levels can reduce atmospheric CO_2 levels that contribute to climate change, and improved soil quality/soil health reduces dust, allergens, and pathogens in the air. Ground and surface water quality improve because better structure, infiltration, and biological activity make soil a more effective filter. For example, organic matter may bind pesticides, making them less active.

What can be done about it?

The most practical way to enhance soil quality/soil health, and as a result air and water quality, is to promote better management of soil organic matter or carbon. Practices that increase organic matter include: leaving crop residues in the field, choosing crop rotations that include high residue plants, using optimal nutrient and water management practices to grow healthy plants with large amounts of roots and residue, growing cover crops, applying manure or compost, using low or no tillage systems, and mulching.

Organic Matter at a Glance

Problems / Indicators - Compaction, slaking, soil crusting, crop moisture stress, poor soil structure	
Causes	**Solutions**
• Soil disturbance • Intensive tillage systems • Low crop biomass (surface and subsurface) • Burning, harvesting or otherwise removing crop residues	• Diverse, high biomass crop rotations • Cover crops • Conservation tillage • Rotational or prescribed grazing • Perennials in rotations • Maintain crop residues on soil surface • Animal manure and compost • Water table management

March 2012

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Resource Concerns

SOIL

Salts and Chemicals

Soil Quality Degradation - Salts and Chemicals

Concentration of salts leading to salinity and/or sodicity reducing productivity or limiting desired use. The resource concern is also applicable to concentrations of other chemicals impacting productivity or limiting desired use.

What is it?

Salinity is a process by which water-soluble salts accumulate in the soil. Saline soils are indicative of inadequate drainage to leach salts from the soil or upward migration of salt from shallow ground water. Sodic soils are high in sodium relative to concentrations of calcium and magnesium. Salinity or sodicity occurs naturally or may result from management practices. Soil formed on parent material high in salts, such as marine deposits, and with inadequate drainage, will be high in salts. Fertilizers, soil amendments (gypsum, lime), and manure may contribute to salinity problems, as well. Applications of saline and/or sodic water without adequate leaching or in the presence of a high water table will increase soil electrical conductivity over time, eventually resulting in saline soil. Soils can also become saline through the process of saline seeps.

Why is it important?

Since few plants grow well on saline/sodic soils, cropping options on these soils may be limited. Salts in the soil can negatively affect water uptake by plants, and saline soils tend to inhibit germination and plant emergence. Growth patterns in cropped fields can be poor, with spotty stand establishment. Under severe salt stress, herbaceous crops appear bluish-green. Leaf tip burn and die-off of older leaves in cereal grains can result from salinity or related drought stress. Salinization degrades the quality of shallow ground water and surface water resources, such as ponds, sloughs, and dugouts.

What can be done about it?

Reducing the severity and extent of soil salinity is accomplished primarily with recharge and discharge water management. Recharge management is used on areas that contribute excess water to the soil and includes decreasing infiltration of excess saline/sodic water and irrigation to maintain salts at a level below the root zone. Discharge management is used on areas where excess water comes to the soil surface and includes growing salt tolerant crops, reducing deep tillage and eliminating seepage.

Salts and Chemicals at a Glance

Problems / Indicators - White crusting of soil, irregular crop growth, and lack of plant vigor	
Causes	Solutions
• Naturally occurring in soils with high concentrations of soluble salts, e.g., sodium, calcium, and magnesium sulfates • Inadequate drainage to leach salt from the soil • Upward migration of salt from shallow ground water • Application of saline and/or sodic water	• Proper use of irrigation water • Salt-tolerant crops • Removal of excess water from recharge areas • Maintenance of the water table at safe levels • Cropping and tillage systems that promote adequate infiltration and permeability • Reducing deep tillage

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