Universal Soil Loss Equation (USLE) Activity

Age: 15-19 years old (grades 9-12), but portions may be adapted for youth 11-14 (grades 6-8)

Objectives:

1. Members/students will know and understand the definition of soil erosion factors and soil conservation strategies.
2. Members/students will recognize that different soils will react differently (more or less erosion) under the same management. They will apply increasing levels of management changes to meet the soil conservation standards for different soils.
3. Members/students will create a soil conservation plan for different soils.

Resources Needed:

- Computers for members/students (recommend at least 1 computer for 3 members/students) with Microsoft Excel and Internet access
- Excel-based computer programs available for free download at: http://www.agronomy.ksu.edu/Teaching/DesktopDefault.aspx?tabid=30
    - USLE AGRICULTURE 2005 - Universal Soil Loss Equation^{tm}, file name USLE2005.xls by S. J. Thien, Kansas State University
- Web-based Soil Survey available at: http://websoilsurvey.nrcs.usda.gov/app/

Preparation:

1. Select 4-5 "real" soil series that are found in your county. One option is to select them from the "Land Use" lesson or go to the web soil survey at http://websoilsurvey.nrcs.usda.gov/app/ and select a large AOI (area of interest – approximately 6,000-9,000 acres) and list 8 soil series with the highest acreages. Avoid any that are "complexes" with two or more series names. Here is example list for an area in and around Garnett, KS.
    - Catoosa silt loam, 1 to 3 percent slopes
    - Kenoma silt loam, 1 to 3 percent slopes
    - Summit silty clay loam, 1 to 3 percent slopes
    - Woodson silt loam, 1 to 3 percent slopes
    - Clareson complex, 1 to 3 percent slopes
    - Mayes silty clay loam, 0 to 1 percent slopes
    - Eram silty clay loam, 3 to 7 percent slopes
    - Mason silt loam, rarely flooded

    Narrow this list by opening USLE2005.xls and selecting the Kfactor worksheet (bottom tab). Find each of your soil series on the box on the right-hand side and write down the K factor and T value for each of the soil series. If you have a "complex," use the soil type listed by USLE2005.xls. For example, Clareson can be flaggy SiCL or just SiCL. I choose to just work with Clareson SiCL (silty clay loam).

Soil Series Name	**K factor**	**T value**
Catoosa silt loam	0.32	3
Kenoma silt loam	0.43	4
Summit silty clay loam	0.37	4
Woodson silt loam	0.43	4

Mayes silty clay loam	0.37	4
Eram silty clay loam	0.37	3
Mason silt loam	0.32	5
Clareson silty clay loam	0.32	2

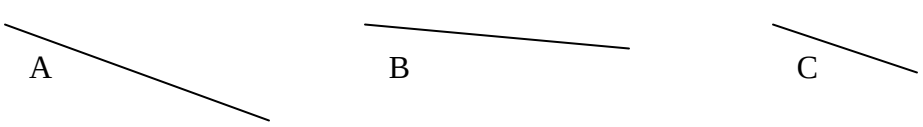
Once you have the K factors and the T values for your list, select 4-5 that are different. In other words, I will choose Clareson, Catoosa, Mason, Kenoma and Summit because they will give me the full range of T values and 2 different K factors for the 4 T value. Choosing soil series with differences will allow students to see how some soils are "easy" to manage, while others require special practices to limit erosion. You will provide your selected list of soil series to the students/members.

Soil Series Name	**K factor**	**T value**
Catoosa silt loam	0.32	3
Kenoma silt loam	0.43	4
Summit silty clay loam	0.37	4
Mason silt loam	0.32	5
Clareson silty clay loam	0.32	2

Interest Approach:
Since at least the late 1930's one industry has really focused on "saving the Earth." They have "been green" for nearly 70 years. That industry is agriculture. Although the Dust Bowl only officially included a few counties, the effects were widespread and changed the way we farm then and now. Why is it in the best interest of farmers to conserve soil? Brainstorm answers (examples): topsoil is nutrient rich and crops yield better with deeper, fertile topsoil; it takes many years to replace topsoil so anything we can do to reduce erosion promotes better soil for growing future crops; fewer acres are being used for production agriculture so farmers have to grow more on less land – that is nearly impossible if soils are not managed for conservation; the bad publicity that follows poor management damages the agriculture industry; nutrients and pesticides are applied to the soil and farmers want them to stay in the field where they can do their job.

In this lesson we will learn what factors impact erosion, specifically water-based soil erosion. We will discover that some soil series (types) are easier to limit erosion on than others. We will consider what activities and management strategies farmers can implement to conserve soil.

Content:
Some definitions should either be covered now or in a previous lesson. Those include:
1. Slope length and slope steepness – draw picture

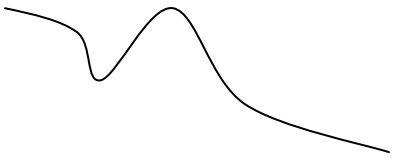


A and B have the same slope length, but A is steeper than B. A and C have the same slope steepness, but C has a shorter slope length. Which slope steepness situation

would result in more soil erosion, A or B? Answer: A. Which slope length situation would result in more soil erosion, A or C? Answer: C. This is a simple application of the force of gravity.

2. Cropping Sequence or Cropping System – the crop grown and the order in which future crops are grown.
3. Tillage – disturbance of the soil to prepare seed bed for plants
4. No-till – no tillage
5. Conservation tillage – minimal tillage, generally not deep
6. Ridge-till – tillage only in the row where seed will be planted, makes a small hill or ridge
7. Plow – deep tillage
8. Contouring – planting crops around a hill or raised area instead of over (in drawing A, not B)

9. Strip cropping – alternating strips of row crop and cover crop
10. Terraces – engineered (man made) hills with channels that reduce slope length and control water flow (see drawing)



Experience: Activity directions:

1. Open USLE2005.xls. Choose "Enable Macros" so the buttons work.
2. Click on the "Start" button.
3. Read, then click on the "Next" button.
4. Read, then click on the "Next" button. May want students to write down this formula and the factors or print this page for future reference.
5. Type in a "R" value appropriate for your area in Kansas. You will have to hit "Enter" or click off the input box before you can select "Next." I will type 225, "Enter" and "Next."
6. Select your first soil series and click "Next." In my case I will select Catoosa.
7. Type 500 ft for a slope length. Type 2% for slope steepness. Click "Next."
8. Click the "Make C-factor Selections" button. I will choose Corn/Sorghum continuous under "Select a Cropping Sequence," Plowed, spring under "What tillage has been used on this site?" 10 under "Percent of soil covered by residue?" Average yield under "Expected yield" and Soybean under "Previous crop?" Note: At first you will want to make the same selections for all your soils. Click "Return." Click "Next."

9. Click the "Make P-factor Selections" button. I will choose No Practice under "Which conservation practice is used?" No terraces under "Which terraces if any are used?" No need to select a "Terrace Interval?" at this time. Click "Return." Click "Next."
10. You will come to the "USLE Results" page. With my choices, I have a predicted soil loss of 12.2 tons per acre per year. For this soil 3 tons per acre per year is tolerable. I have too much erosion with this system.
11. Choose "Save as" and save the file with the soil series name. In other words, I named the file Catoosa.
12. Go back to the Kfactor worksheet (bottom tab). This time select your next soil. After changing the soil, hit the "Results" button. I choose "Kenoma" and my soil loss increased to 16.4 tons per acre per year. "Save as" this file with this soil series name (i.e. Kenoma).
13. Repeat the practice only changing the soil series and then "Save as" the new soil.
14. Open all your soil named files. Don't forget to "Enable Macros."

Share: Write down all your inputs
R factor – 225
K factor – Catoosa, Kenoma, Summit, Mason, Clareson
LS factor – Slope length – 500; Slope steepness – 2%
C factor – Cropping sequence – corn/sorghum continuous; Tillage – spring plow; Residue cover – 10%; Expected yield – average; Previous crop – soybean
P factor – Conservation practice – none; Terrace – no terraces

Develop a table sharing the soil series name, predict soil loss, and tolerable soil loss such as below:

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Catoosa silt loam	12.2	3
Kenoma silt loam	16.4	4
Summit silty clay loam	14.1	4
Mason silt loam	12.2	5
Clareson silty clay loam	12.2	2

Process: Imagine you are farming a particular field in your county. Which of the Universal Soil Loss Equation factors can be changed (within reason)? Answer: C factors and P factors. You can make choices in the crops grown, tillage, etc (C factor) and conservation practices used such as contouring and terraces (P factor.) You cannot control the rainfall for an area, so changing the R factor is impractical. A particular field is going to have a particular soil (or soils). You can't change it out, so changing the K factor won't work. Although you can do some things to impact the LS factor, you probably can't afford to level the entire field, so changing LS isn't easy. In the "real world" you can only impact erosion on a given field with C and P factors, let's try some "low-cost" options first.

Recommended order for C and P factor changes
Tillage – Conservation
Practices – Contouring
Cropping Sequence
Previous Crop
Tillage – No-till
Residue Cover – related to tillage choice
Strip Cropping
Terraces
Cropping Sequence – perennial forage crop

Generalize: Go to the Cfactor worksheet or tab. Almost no one plows fields regularly anymore due to extreme erosion problems. Therefore, change the "Tillage" to Conservation-till for all the soils. Select the "Make C-factor Selections" button for each spreadsheet soil, select, "Conservation-till," "Return," then "Results." Make (or copy and paste) tables with soil series name, predicted soil loss, and tolerable soil loss after each modification. List the modifications made from the original inputs above the table.

With Conservation-till

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Catoosa silt loam	5.7	3
Kenoma silt loam	7.7	4
Summit silty clay loam	6.6	4
Mason silt loam	5.7	5
Clareson silty clay loam	5.7	2

Wow, that is a big change! If any of your soils now result in a "soil conserving system" you can save it and close the file (no need to make additional changes). If not, keep making changes (in a logical order) until the soil series results in a "soil conserving system."

Go to the Pfactor worksheet or tab. Of all the options listed, probably contouring will be the least expensive soil conserving practice. Select the "Make P-factor Selections" button for each spreadsheet soil, select "Contouring," "Return," then "Results."

With Contouring and Conservation-till

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Catoosa silt loam	3.4	3
Kenoma silt loam	4.6	4
Summit silty clay loam	4.0	4
Mason silt loam	3.4	5
Clareson silty clay loam	3.4	2

If any of your soils now result in a "soil conserving system" you can save it and close the file (no need to make additional changes). Highlight the row(s) and remove that soil series from future tables. If no soils series are "soil conserving" with your C and P factor

changes, keep making changes (in a logical order) until the soil series results in a "soil conserving system."

Go to the Cfactor worksheet or tab. Select the "Make C-factor Selections" button for each spreadsheet soil, select, "Soybeans continuous," "Return," then "Results."

With Soybeans continuous, Contouring and Conservation-till

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Catoosa silt loam	4.5	3
Kenoma silt loam	6.1	4
Clareson silty clay loam	4.5	2

Oops, that made it worse! However, maybe you really want to grow soybeans. Can you make some other modifications so you can have a "soil conserving system?"

Go to the Cfactor worksheet or tab. Select the "Make C-factor Selections" button for each spreadsheet soil, select, "No-till," "20" percent residue cover, "Return," then "Results."

With No-till, 20% residue cover, Soybeans continuous and Contouring

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Catoosa silt loam	4.3	3
Kenoma silt loam	5.7	4
Clareson silty clay loam	4.3	2

Go to the Cfactor worksheet or tab. Select the "Make C-factor Selections" button for each spreadsheet soil, select, "Soybeans/sunflower not continuous," "Other" previous crop, "Return," then "Results."

With Soybeans/sunflower not continuous, Other previous crop, No-till, 20% residue cover, and Contouring

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Catoosa silt loam	2.5	3
Kenoma silt loam	3.4	4
Clareson silty clay loam	2.5	2

Go to the Pfactor worksheet or tab. Select the "Make P-factor Selections" button for each spreadsheet soil, select "Terraces, open outlets," "180-225 ft" terrace intervals, "Return," then "Results."

With Terraces, open outlets, 180-225ft terrace intervals, Soybeans/sunflower not continuous, Other previous crop, No-till, 20% residue cover, and Contouring

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Clareson silty clay loam	2.3	2

Apply: What if I told you the land capability class for Clareson complex, 1 to 3 percent slopes was 6? What might you do differently?

Change all factors so the inputs are:
R factor – 225
K factor – Catoosa
LS factor – Slope length – 500; Slope steepness – 2%
C factor – Cropping sequence – grass/legume mix; Tillage – no-till; Residue cover – 50%; Expected yield – average; Previous crop – grass/legume mix
P factor – Conservation practice – none; Terrace – no terraces

Soil Series Name	Predicted Soil Loss	Tolerable Soil Loss
Clareson silty clay loam	0.0	2

Summary:

- There are five factors that affect soil erosion due to water:
  - Rainfall and Runoff
  - Soil Texture/Type
  - Slope Length and Steepness
  - Cover (such as residues or growing crops)
  - Practices (such as terraces and contour farming)
- For a given site/location, we can only practically control/impact the cover and practices.
- Different soils react differently under the same management and will have different tolerances for soil erosion before consequences become evident.
- Cover management and practices can be implemented with progressively more effort or expense required. With some soils, a change in land use (i.e. growing perennial forage crops instead of annual row crops) is needed to meet soil conservation standards and expectations.

Assessment:
Develop a soil conservation plan for each "field" containing your assigned soils. Discuss the adaptations and modifications you would recommend for each field based on this exercise. List the characteristics you cannot change. Include the tolerable soil loss for the soils and the predicted soil loss based on your recommendations.

> Example – The tolerable soil loss for a field primarily made up of Kenoma silt loam soil is 4 tons per acre per year. For this field, the R factor (rainfall and runoff) is approximately 225, the slope length is 500 feet, and it has a 2% slope. Crop, cover and management practices recommended to reduce soil loss to or below tolerable levels include: growing soybeans or sunflowers in rotation with other crops (not continuous), use no-till management which will increase percentage of residue cover, and farming on the contour. With these strategies, predicted soil loss can be reduced to 3.4 tons per acre per year which is below the tolerable soil loss for the Kenoma soil series.

References:

USLE AGRICULTURE 2005 - Universal Soil Loss Equation[tm], file name USLE2005.xls by S. J. Thien, Kansas State University. Available online at http://www.agronomy.ksu.edu/Teaching/DesktopDefault.aspx?tabid=30 accessed [02/09/2011].

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/ accessed [02/09/2011].

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