Modeling Wind Erosion

- Wind Erosion Equation:
- $E=f(I', K', C', L', V')$
- E is average soil loss
- I’ is soil erodibility index
- K’ is soil ridge roughness factor
- C’ is climate factor
- L’ is width of unsheltered field
- V’ is equivalent vegetative cover factor

Soil Wind Erodibility Index (I')

- Expresses the potential annual wind erosion in tons/acre/year, from a site that is wide, level, unsheltered, and isolated; has a bare, smooth, loose, and non-crusted surface; and has climate conditions like those in the vicinity of Garden City, Kansas
- Available on soil survey

Ridge Roughness Factor (K’)

- A function of Ridge height and frequency
- Therefore will change throughout the year based on tillage management

Climate Factor (C’)

- Incorporates wind velocity
- Also incorporates soil moisture content resulting from rainfall and evapotranspiration.

Width of Field Factor (L’)

- Unsheltered distance across the field
- Incorporates the deviation from prevailing wind direction
  - Important when estimating erosion when ridges/crops are place perpendicular to prevailing wind direction.

Vegetative Factor (V’)

- Incorporates the amount, and geometry of vegetation on the soil surface.

Limitations of the Wind Erosion Equation

- Empirical equation similar to USLE
  - Based on experimental observations
- Assumes that soils (texture and ridges) are homogeneous
- The Original C’ factors were only suitable for use in the high plains region of the U.S
- Did not account for Random roughness
- Did not account for effects of soil freezing, which renders them nonerodible

Limitations of the Wind Erosion Equation

- The factors in the WEQ often interact with each other and therefore it requires complex equations and tables
  - However these do not accurately account for the complex interactions affecting wind erosion
- Therefore the NRCS developed Revised WEQ and an Excel spreadsheet
  - Website containing RWEQ

Revise Wind Erosion Models

- More accurately portrays the physical processes of wind erosion
- Estimates wind erosion based on wind velocity, rainfall characteristics, soil roughness, erodible fraction of soil, crusts, surface residues and other dynamic factors.
- Under continuous development to incorporate a greater # of conditions

Wind erosion Prediction System

- Process based and provides continuous, daily time-step estimates of erosion
- Can predict erosion from nonuniform fields
- It can estimate suspension separate from saltation and creep
  - RWEQ and WEQ did not distinguish between them.
- Can predict erosion from a single storm on a daily, weekly, monthly or yearly basis.
- Website for WEPS

Management of Wind Erosion

- Goals:
  - Reduce wind speeds at the soil surface
  - Remove abrasive material from the wind stream
  - Reduce soil erodibility

- Maintaining permanent vegetation and/or residue is the **most effective** way to minimize wind erosion

Wind breaks

- Strips of trees, shrubs or tall grasses .
- Reduce wind speeds
  - Wind velocities will be reduced for a distance 30-35 times the height of the wind break on the downwind side
  - Velocities can be reduced by 70% at a distance of 10X the height of the break.
- Trap eroding material
- Can shorten length of eroding surface

Some Limitations to the use of Wind Breaks

- Lack of suitable species for the environment.
- Loss of cropland acres
- High cost of establishment.
- Host for pests
- Attraction for birds that may consume grain crops
- Competition of barrier with crops for light, water and nutrients.

Crop Residues

- Increase surface roughness
- Standing/anchored residue combined with coarse residues on the soil surface is the most effective practice to control wind erosion
  - Maintains surface soil moisture, which decrease erodibility
- Protects emerging seedling from abrasion

Flat(detached) vs Standing (anchored) Residues

- Standing/intact residue is much more effective than flat detached residue
- Detached residue can simply blow away
- Standing residue reduces wind velocities near the surface and will capture suspended and saltating particles near the surface.