SOIL CONSERVATION SOCIETY OF AMERICA

SYMPOSIUM ON SOIL EROSION BY WIND

February 23-24, 1987

Clarion Hotel   Denver, Colorado

Sponsored by the Colorado Chapter of the Soil Conservation Society of America with assistance from USDA-SCS; Great Plains Agricultural Council; CSU Department of Agronomy; Colorado Cooperative Extension; Colorado Association Soil Conservation Districts and Colorado Conservation Tillage Task Force.

PRINCIPLES OF SOIL EROSION: DETACHMENT, MOVEMENT, AND DEPOSITION

D. V. Armbrust

Areas of the world susceptible to wind erosion include most of North Africa and the Near East, parts of southern and eastern Asia, Australia, southern South America, parts of Russia, and the arid and semiarid parts of North America. Wind erosion is the dominate problem on about 90 million acres of land in the United States with approximately 5 million acres moderately to severely damaged each year. Over 1 million acres were damaged during the 1983-84 blow season in Colorado.

The great economic losses and social disruptions caused by the drought and resulting wind erosion during the "Dirty Thirties" focused national attention on the problem of wind erosion and stimulated various State and Federal agencies to establish research into the basic causes, effects, and methods of control.

Wind erosion can occur whenever: (1) the soil is loose, dry, and finely divided; (2) the soil surface is smooth and vegetative cover is sparse or nonexistent; (3) the field is sufficiently large; and (4) the wind velocity is high enough to move soil.

The most easily detached soil particles or sand grains, between 0.1 and 0.5 mm in diameter, begin to roll or vibrate with increasing intensity until they leave the surface as if ejected. These particles rise almost vertically, travel 10 to 15 times their height of rise, and return to the surface with an angle of 6 to 12 degrees from the horizontal. After striking the surface, the particles either rebound and continue on to strike the surface again or they impart their energy to other particles causing those particles to be ejected or to roll along the surface. The process of bouncing across the surface is called saltation. Wind erosion continues only when saltation size particles are present on the surface.

The rolling or sliding of particles along the surface, which is driven by the saltation flow, is called surface creep.

The impact of the saltating particles generates additional saltating particles as well as smaller particles, less than 0.1 mm in diameter, which can become suspended by the wind's eddies and be carried to great heights. These suspended particles, while only a small percentage of the total moved by wind erosion, are the most spectacular and can be seen at great distances.

Creep size particles rarely leave the field. Saltation sized particles are deposited behind or around any obstacle which lowers the force of the wind enough so particles can no longer be carried. Suspension size materials are carried great distances until the wind decreases or rainfall removes them from the atmosphere.

Wind erosion sorts the soil by removing the most fertile portion, fills road ditches, reduces plant stands, lowers quantity and quality of plant yields, transmits plant diseases, reduces visibility, pollutes the air, and impairs animal and human health.

The late W. S. Chepil incorporated nearly 30 years of research into the development of the Wind Erosion Equation. The first equation related the soil loss in a wind tunnel to the percent soil cloddiness, the amount of surface crop residue, and degree of surface roughness. The present equation relates the average annual soil loss from a field to 11 individual soil and climatic variables and is designed to do two functions: (1) Determine if a field is adequately protected from wind erosion; and (2) Determine the different field conditions of cloddiness, roughness, vegetative cover, shelter of barriers, field width and orientation required to reduce wind erosion to a tolerable amount under different climates.

The 11 primary variables that control wind erodibility are:

(1) Soil Erodibility Index, I, the potential soil loss in tons per acre per annum from a wide, unsheltered, isolated field with a bare, smooth, noncrusted surface under the climatic conditions in the vicinity of Garden City, Kansas.

(2) Knoll Erodibility, I_s, accounts for the effect of windward slopes of less than 500 feet if a knoll exists in the field.

(3) Surface Crust Stability, F_s, is the mechanical stability of the crust.

(4) Soil Ridge Roughness, K_r, is the roughness of the soil surface caused by ridges and furrows.

(5) Velocity of Erosive Wind, v, is the mean average wind speed corrected to 30 feet.

(6) Soil Surface Moisture, M, accounts for the resistance of soil moisture on soil particle movement.

(7) Distance Across Field, D_f, is the distance across the field measured along the prevailing wind erosion direction.

(8) Sheltered Distance, D_b, is the distance along the prevailing wind erosion direction that is sheltered by a barrier.

(9) Quantity of Vegetative Cover, R', is the amount of surface crop residue in pounds per acre.

(10) Kind of Vegetative Cover, S, is the factor describing the total cross-sectional area of the vegetative material.

(11) Orientation of Vegetative Cover, K_O, is the vegetative roughness factor.

Because of the nature of the relationship between E and the 11 variables, the present Wind Erosion Equation combines I and I_s into I; v and M into C; D_t and D_b into L; and R', S, and K_o into V. F_s is ignored and K_r becomes K so the new equation looks like this:

$$E = f(I,K,C,L,V)$$

where: E = Potential average annul soil loss
I = Soil erodibility
K = Ridge roughness factor
C = Local climatic factor
L = Field width
V = Equivalent quantity of vegetative cover

The information needed to solve the equation for a particular field are the percent of aggregates larger than 0.84 mm in diameter, height and spacing of ridges, width of field, height of barrier if present, and kind, orientation, and amount of residue. This information plus the proper maps, graphs, and tables are used to solve for E in five steps. The equation can also be solved using a special slide rule, a computer program, or computer generated tables.