DEPARTMENT OF AGRICULTURAL ENGINEERING

AI3402 SOIL AND WATER CONSERVATION ENGINEERING

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2.21 Modified USLE

Williams (1975) modified the USLE to estimate sediment yield for a single runoff event. On the basis of that runoff is a superior indicator of sediment yield than rainfall; i.e., no runoff yields no sediment, and there can be rainfall with little or no runoff- Williams (1975) replaced the R (rainfall erosivity) factor with a runoff factor. His analysis revealed that using the product of volume of runoff and peak discharge for an event yielded more accurate sediment yield predictions, especially for large events, than the USLE with the R factor. The Modified USLE, or MUSLE, is given by the following (Williams, 1975):

$$S = 11.8 (Q \times q_p \times A)^{0.56} \times K \times C \times P \times LS \times CFRG$$

Where,

S = Sediment yield for a single event in (Mg),

Q = Total event runoff volume (m^3),

q_p = Event peak discharge ($m^3 s^{-1}$),

A = Area of the hydrologic response unit (HRU) (ha) and

K, LS, C, and P = USLE parameters and these are dimensionless.

CFRG = Coarse fragment factor, which is estimated as

$$CFRG = \exp(-0.053 \times Rock)$$

Where, Rock is % rock in the uppermost soil layer.

The MUSLE approach has been used to estimate sediment yield at various sites. Some errors, however, have been associated with both USLE and runoff model estimates, resulting in under- and over-prediction of sediment yield from various rainfall events and site-specific characteristics, and have led to various proposals to increase accuracy after regression analysis. The complexity of watershed systems has forced modelers and users to develop modified, calibrated or revised versions of the MUSLE. Due to errors associated with the classic USLE, especially those relating to topographic factors in terms of limited availability of data on steep slope gradients; it is still unclear how the USLE can be applied to complex slopes beyond the range of the extended model. Application of the MUSLE has not been documented. The structure of the MUSLE model has inherited some limitations from classic USLE, especially those related to slope steepness (S factor).

2.22 Revised USLE

The science of predicting soil erosion and sediment delivery has continued to be refined to reflect the importance of different factors on soil erosion and runoff. The Revised Universal Soil Loss Equation (RUSLE) has improved the effects of soil roughness and the effects of local weather on the prediction of soil loss and sediment delivery. The importance of estimating erosion and sediment delivery has long been recognized to plan for minimizing the pollution by sediments as well as the chemicals carried with soil particles. The visual effects of erosion include rills and gullies and sediment blockages found in culverts or drainage ditches. A well planned and engineered erosion control and/or water management plan will alleviate many concerns about construction site erosion and potential pollution. RUSLE is a science-based tool that has been improved over the last several years. RUSLE is a computation method which is used for site evaluation and planning purposes and to aid in the decision process of selecting erosion control measures. It provides an estimate of the severity of erosion. It also provides numbers to substantiate the benefits of planned erosion control measures, such as the advantage of adding a diversion ditch or mulch. For example, a diversion may shorten the length of slope used in calculating a LS factor. Also, the application of mulch will break raindrop impact and reduce runoff. This section provides a method to calculate soil loss. Following the step-by-step procedure will provide estimated erosion in terms of mass per unit area per year, which can be converted to the more usable unit. [If an electronic version is preferred, RUSLE, the computer model, is available from the Natural Resources Conservation Service, United States Department of Agriculture. The recent version (RUSLE-2) was released for implementation in 2003]. Currently, there is no method to predict soil loss from concentrated flow areas and gullies.

Soil losses on construction sites can be predicted by using the Revised Universal Soil Loss Equation (RUSLE). The equation is as follows:

For bare ground conditions of graded areas of construction sites

A = R*K*(LS)*C* P

Where:

A is the computed soil loss Mg ha^{-1} $year^{-1}$.

R is the rainfall value reflecting the energy factor multiplied by the intensity factor.

EI is the abbreviation for energy and intensity and is called the Erosion Index. The energy component is related to the size of the raindrops while the intensity is the maximum intensity for a 30-minute interval and is measured in inches per hour. EI is frequently illustrated in graphs by showing the percent of EI that occurs within a period of days or months. From the index, one can determine the period when the most intense storms are likely to occur.

Example 1: Using the given information, determine the sediment yield from a storm with a total runoff volume of 120 m^3 and a peak discharge of 5 m^3/s.

Solution:

K = 0.33

LS = 0.697

C = 0.004

P = 0.5

$(Q\ q_p)^{0.56} = (120 \mathbf{x} 5)^{0.56} = (600)^{0.56} = 36$

$S = 95\ (Q \times q_p)^{0.56} \times K \times C \times P \times LS$ = P95 x 36 x 0.33 x 0.697 x 0.004 x 0.5 = 1.57 Mg.

Table 18.1, 2,3, show list of the cover factor C values for planted cover crops for erosion control at construction sites.