NON-AGRICULTURAL C AND P VALUES FOR RUSLE[1]

R.D. Karpilo, Jr.[2] and T.J. Toy

Abstract: There is little consensus in the erosion-science community concerning which values for the cover-management factor (C-factor) and the supporting practice factor (P-factor) should be used when the Revised Universal Soil Loss Equation (RUSLE) is applied to non-agricultural lands such as mined lands and construction sites. Likewise, there is uncertainty and inconsistency concerning the C and P values to use to account for the effects of various erosion-control products and devices. The C and P factors developed originally for use on agricultural lands may not be directly applicable to other types of land disturbances, such as mined lands and construction sites. The purpose of this study is to examine the C and P RUSLE factors used for non-agricultural applications. Over 1100 individuals who downloaded RUSLE software from the USDA-ARS-National Sedimentation Laboratory website between December 1998 and February 2003 were contacted via email and asked to complete a survey detailing their use of RUSLE. The departments of transportation in each of the 50 US states were contacted to determine which C and P values they use to calculate soil loss from highway construction sites. Several major manufacturers of erosion-control products and devices were also contacted to ascertain which C and P values they recommend for use with their products and how those values are derived. In addition, several erosion-science professionals were contacted to learn which C and P values (and the sources of those values) they utilize for non-agricultural RUSLE applications. The results of this inquiry indicates that the majority of the C and P values applied to non-agricultural land disturbances are either largely based on the agricultural values or are supported by little or no scientific analysis. Those C and P values found to have been calculated using the methods outlined in *Agriculture Handbook 703* (Renard et al. 1997) were considered the most appropriate values to use when RUSLE is applied to non-agricultural land disturbances.

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Introduction

- The Revised Universal Soil Loss Equation (RUSLE) is increasingly being applied to a wide-variety of non-agricultural land-use conditions, including: disturbed forest lands, landfills, construction sites, mining sites, reclaimed lands and military training lands.
- There is little consensus in the erosion-science community concerning which values for the cover-management factor (C-factor) and the supporting-practice factor (P-factor) should be used when the Revised Universal Soil Loss Equation (RUSLE) is applied to non-agricultural lands.
- Likewise, there is uncertainty and inconsistency concerning the C and P values to use to account for the effects of various erosion-control products and devices.
- The purpose of this study is to examine the C and P RUSLE factors currently being used for non-agricultural applications, determine which values are most appropriate, and identify future research needs associated with the selection and calculation of C and P factors.

The RUSLE C-Factor

- The cover-management factor (C-factor) is a dimensionless number, ranging between 0 and 1, that represents the degree of protection from erosion provided by crops, vegetation, or erosion-control products at a particular site.
- The C-Factor is perhaps the most important factor in RUSLE because: (1) it represents surface conditions that are easily managed for erosion control, and (2) the values range from virtually 0 to slightly greater than 1, strongly influencing the soil-loss rate (Toy et al. 1999).
- Well-protected soil has a value near zero; while bare soil has a value near one.
- The utility of RUSLE was extended by the use of a sub-factor approach to calculate site-specific cover-management factors.
- These sub-factors include: vegetation canopy, raindrop fall height, soil surface cover and roughness, root biomass, and prior land-use.
- The developers of RUSLE recommend that C-factors be computed using the RUSLE model rather than selected from table values.
- By using this approach, RUSLE can confidently be applied to a diverse variety of environments, including mined land and construction sites (Toy et al., 1999).

The RUSLE P-Factor

- *Agriculture Handbook 703* (Renard, et al. 1997) defines the supporting practice factor as: “the ratio of soil-loss with a specific support practice as compared with soil under unit-plot conditions.”
- For this study of C-factors, the P-factor values are taken as 1.0, because this assumes that no special "practices" (i.e. terracing, contouring, etc.) will be used.
- The use of silt fences or other storm-water management/ sediment-control practices may be integrated into RUSLE using a P-factor value that is less than 1.0 (Sprague 1999).
- P-factors given in *Agriculture Handbook 703* are considered to be the appropriate factors for use with RUSLE.
- Like the C-factor, many of the values currently in use for the P-factor are without solid scientific foundation.
- The P-factor for each support practice should be computed by multiplying individual support practice sub-factors together.

Methods

- Over 1100 individuals who downloaded RUSLE software from the USDA-ARS-National Sedimentation Laboratory website between December 1998 and February 2003 were contacted via email and asked to complete a survey detailing their use of RUSLE.
- The seven survey questions included:
  - 1. Which version of RUSLE are you currently using?
  - 2. How often do you use RUSLE?
  - 3. Under what land-use conditions are you applying RUSLE?
  - 4. Please describe a typical example of how you use RUSLE.
  - 5. What values are you using for the cover-management (C-factor) and the supporting practice (P) factors in your application of RUSLE?
  - 6. What are the sources of these C and P values?
  - 7. What improvements would you like to see in future iterations of RUSLE?
- The Department of Transportation in each of the 50 US states also was contacted to ascertain which C and P values they use to calculate soil loss from highway construction sites.
- Several major manufacturers of erosion-control products and devices were also contacted to determine which C and P values they recommend for use with their products and how those values were derived.
- The erosion-science literature was also reviewed to determine which C and P-factors are currently used on non-agricultural lands.

Data

- 190 individuals responded to the survey (17%).
- 40% of those who replied had downloaded RUSLE but decided not to use it.
- 114 RUSLE users completed the survey.
- The following is a breakdown of the land-use conditions for which respondents applied RUSLE:
  - Cropland 23%,
  - Rangeland 14%,
  - Forestland 13%,
  - Landfills 9%,
  - Construction 16%,
  - Reclaimed Lands 9%,
  - Mining 7%,
  - Military Lands 4%,
  - Other 4%.

Data Continued

- The following are the sources of non-agricultural C and P-values indicated by respondents (note: crop land and rangeland-users were not included in these figures):
  - Guesses/Assumptions/Don't Remember 34%,
  - Literature 27%,
  - NRCS 19%,
  - Site-Specific Calculations 7%,
  - Consultation with Experts 3%,
  - USLE Tables 3%,
  - Values from the RUSLE Program 3%,
  - Can't Release Sources 3%.

- The results of contacting each state department of transportation (DOT) were disappointing because most of the state departments of transportation do not use RUSLE.
- Only North American Green readily supplied C-values for their erosion-control products.
- Several other companies were reluctant to provide values.

Which C and P-factors are currently being used for non-agricultural applications?

- It seems that most non-agricultural users of RUSLE are somewhat confused concerning which C and P factors to select for their applications.
- Potential RUSLE users may be scared away by the lack of clear consensus concerning which values to select.
- A large portion of the 40% who responded to the survey but had decided not to use RUSLE indicated that their decision was due to a lack of confidence in choosing C and P-factors.
- The C factors currently used vary immensely.
- They range from users who are blindly guessing and estimating, to users who are just entering C-factors they read or heard about somewhere, to users who are tediously calculating site specific C-factors using measured sub-factor inputs.

Which C and P-factors are currently being used for non-agricultural applications? (cont.)

- Several full-scale field tests and rainfall simulator studies have resulted in the calculation of C-factors for slopes protected with rolled erosion control products (RECP) (Austin and Ward, 1996).
- Few manufactures of erosion control products have applied these calculated C-factors to individual products.
- The majority of non-agricultural RUSLE users are assuming that no special "practices" (i.e. terracing, contouring, etc.) are being used and simply leave the P-factor as 1.0.
- This is appropriate given that no operation or activity is undertaken that disrupts the soil “on or near the contour and results in storage of moisture and reduction of runoff (Renard et al. 1997).”
- A small minority of users are attempting to account for the effectiveness of hay bales, silt fences, “pocking” and other storm water management/ sediment control practices by assigning P-factors of less than 1.0.
- Additionally, a few others are assigning a P-factor greater than 1.0 to account for surface compaction.

Analysis

- Based on the preliminary results of this study, it seems clear that between non-agricultural RUSLE users, there is major incongruity in both the values of C and P-factors being used and the rational behind their selection.
- The lack of industry-wide consensus of which values to select seems to be contributing to the avoidance of using RUSLE and a sense of mistrust associated with soil-loss calculations made using RUSLE in non-agricultural situations.
- It is likely that soil-losses are being unintentionally over or under calculated as a result of inexperienced or uninformed users selecting C and P-factors based on generalizations and cursory reviews of literature (Hickman, 2002).

Which C and P-factors are the most appropriate?

- When the equation is used to estimate erosion from non-agricultural disturbances, unique C- and P-factors developed specifically for these applications should be used (Sprague 1999).
- The reduction in erosion that results from hay bales, silt fences, “pocking” and other storm-water management/sediment control practices should be accounted for by using P-values less than 1.0.
- Because little empirical support exists in the literature, it is difficult to suggest specific values.
- More research into this matter is needed.
- The users selecting values greater than 1.0 to account for the effects of compaction also may be making a mistake.
- The most prudent method of selecting a C-value for a non-agricultural application is to follow the tabulated procedures outlined in *Agriculture Handbook 703* (Renard et al, 1997).
- In order for a C-factor to accurately represent local cover conditions, site-specific sub-parameters (canopy cover, raindrop fall height, surface cover/roughness, root biomass, prior land-use, and soil-moisture) must be obtained.

Which C and P-factors are the most appropriate? (cont.)

- Typically this requires a detailed study for each area in which RUSLE will be applied.
- This method most likely minimizes potential errors in soil-loss calculations; but is time and money intensive.
- The next best option according to *Agriculture Handbook 703* (Renard et al, 1997) is to obtain data from the literature.
- Using older USLE C and/or CP values may also be a workable solution provided they have been recently locally verified.
- If no literature is available, there is a chance that the NRCS has developed data that can be used directly or adapted (Renard et al, 1997).
- A last resort is to identify a cover type listed in the RUSLE Crop database that is comparable to the vegetation found in the study area and adjust the parameter values accordingly (Renard et al, 1997).
- Beyond these options the validity of calculations made with other C-factors are likely suspect.

Conclusions

- There is little consensus concerning which values for the C-factor and the P-factor should be used when RUSLE is applied to non-agricultural lands.
- More empirical research is needed to provide reliable P-factors for hay bales, silt fences, “pocking” and other storm-water management/sediment-control practices.
- Additional studies should be conducted to determine how RUSLE should account for soil compaction.
- Very few users are taking advantage of the sub-factor approach in calculating C-factors.
- Site-specific C-factors likely provide the best calculation of soil-loss.
- Care must be taken in the selection of C-factors, because substantial miscalculations are possible.

Literature Cited

- Austin, D.N., L.E. Ward. 1996. ECTC provides guidelines for rolled erosion control products. Geotechnical Fabrics Report. January/February.

- Hickman, R. Personal communication, October 18, 2002.

- Renard, K.G., Foster, G.R., Weesies, G.A., McCool, D.K, and Yoder, D.C., coordinators. 1997. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Soil Loss Equation (RUSLE). U.S. Dept. of Agriculture, Agric. Handbook No. 703, 404 pp.

- Sprague, C.J. 1999. Green engineering design principles and applications using rolled erosion control products. Civil Engineering News, March.

- Toy, T.J., G.R. Foster, and K.G. Renard. 1999, RUSLE for mining, construction and reclamation lands: Journal of Soil and Water Conservation v. 54, no. 2, p. 462-467.