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Understanding Soil Erosion Risk Following Timber Harvesting

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Introduction and Background

Soil erosion is the detachment, transport, and loss of soil particles from the land surface by agents such as rainfall, surface runoff, wind, or human disturbance. In forestry, soil erosion is an important concern on timber harvest sites because harvesting activities can disturb the soil surface and increase the risk of soil loss and sediment movement into nearby streams and waterways (Parajuli et al., 2022; Picchio et al., 2021). Over time, various approaches have been developed to estimate soil erosion rates (Table 1). This info sheet provides an overview of soil erosion prediction on forest land and offers guidance on using the Universal Soil Loss Equation (USLE) to estimate potential erosion rates following timber harvest operations. This info sheet is intended for forest landowners, foresters, logging professionals, and natural resource managers who are interested in assessing erosion risk on forest harvest sites. By understanding erosion risk, they can select and implement appropriate Best Management Practices (BMPs) to minimize soil loss, protect water quality, maintain site productivity, and reduce environmental impacts associated with harvesting activities (Parajuli et al., 2024; Rijal et al., 2023).

Table 1. Soil erosion assessment methods.

Method	Description	Scale	Best for
Sediment capture	Erosion can be measured by physically capturing sediments or monitoring soil level changes. Common sediment capture techniques include runoff plots, sediment traps/check dams, silt fences, and sediment collection tanks.	Plot to small watershed	Field checks; short-term erosion; small experiments
Water sampling	Measuring suspended sediments in runoff water. Common water sampling techniques include grab sampling and automatic water samplers.	Event/continuous	Storm event monitoring; water quality; sediment transport quantification
Tracer techniques	Estimating past erosion by analyzing natural or artificial isotopes. Common tracer techniques include compound-specific stable isotopes and fallout radio nuclides.	Hillslope-watershed	Long-term erosion; sediment source tracking
Geotechnical tests	Tests soil resistance to erosion under controlled hydraulic conditions, such as Jet or Hole Erosion Tests.	Lab/site-specific	Infrastructure design; levee/dam safety
Erosion prediction models	Uses empirical or physical models, such as USLE/RUSLE and WEPP, to estimate soil loss.	Plot-regional	Planning; scenario modeling; GIS-based erosion mapping

Erosion Prediction Models

Erosion prediction models are commonly used to estimate soil loss under different site and management conditions. Common models include the Universal Soil Loss Equation (USLE), Revised Universal Soil Loss Equation (RUSLE), and Water Erosion Prediction Project (WEPP). Among these models, USLE has been widely used for estimating erosion in forestry. The U.S. Department of Agriculture Forest Service[1] guide by Dissemeyer and Foster (1984) provides step-by-step guidance for predicting erosion on forest land by considering key factors that contribute to soil loss. Access the guide using the embedded link or QR code.

Below are the specifics on using the USLE method for estimating soil erosion potential on harvest sites. For estimating soil erosion on harvest sites, the six operational areas within a timber harvest site (forest roads, skid trails, stream management zones (SMZs), stream crossings, harvest area, and landings) can be categorized into tilled (topsoil removed) and untilled groups (no topsoil removed). SMZs and harvest areas fall into the untilled group, while the rest fall into the tilled group. Soil erosion needs to be estimated from each operational category in order to get the overall average erosion from the harvest site. All references to Figures and pages refer back to the USLE manual (not in this info sheet).
The equation for estimating erosion in USLE-Forest is:

Erosion rate (tons/acre/year) = R×K×LS×CP

Where,

1. **R (Rainfall and Runoff Index)**

   The amount of rainfall contributing to erosion is measured as the number of rainfall erosion index units. In Kentucky, this value varies from ~ 150 in eastern region to ~ 250 in the western region. The USLE method uses a rainfall index provided in Figure 1, page 3 in the manual.

2. **K (Soil Erodibility)**

   Soil erodibility is a measure of a soil's susceptibility to erosion. Usually, the soil erodibility value varies with the soil type. To check the K factor for a particular harvest site, see page 36 in the USLE manual or visit the UC Davis SoilWeb[2]. You can also scan the QR code to access the Web, enter the harvest site location, and locate the corresponding K-factor.

3&4. Slope length, slope steepness, and LS (slope length and steepness)

The combined influence of slope length and gradient on erosion is considered in this step. Field measurements of slope gradient can be done using a clinometer (percent slope), while slope length can be measured with a tape or by pacing. The values for LS factors can be found in Table 1, page 5, or Figure 3, page 6 in the USLE manual. For instance, with a slope of 5 percent and a length of 50 feet, the LS value is 0.379.

5&6. CP (cover and management practice factor for untilled and tilled forest land)

Operational areas need to be categorized as tilled or untilled, and to obtain this value, you must evaluate the subfactors and multiply them together to get the CP value. If a subfactor is not applicable, assign it to a value of 1. The subfactors are given below.

[1]https://www.ars.usda.gov/ARSUserFiles/60600505/RUSLE/A%20guide%20for%20predicting%20sheet%20and%20rill%20erosion%20on%20forest%20land.pdf
[2]https://casoilresource.lawr.ucdavis.edu/gmap/

Example of erosion estimation on a harvest site using the USLE-Forest method

Untilled Area	**Tilled Area**
CP Subfactors for minimal disturbance	CP Subfactors for disturbed soils (roads)
a. Bare soil and fine roots = 0.036	a. Bare soil, residual binding, and soil reconsolidation = 0.045
b. Canopy = 0.58	b. Canopy = 0.58
c. Steps = 0.93	c. Steps = 0.93
d. Onsite storage = 0.8	d. Onsite storage = 0.8
e. High organic matter content = 0.7	e. Invading vegetation = 0.87
	f. Contour tillage = 1
Total CP for untilled = 0.011	Total CP for tilled = 0.017

Once CP is calculated, multiply R, K, LS, and CP to get the estimated erosion value.

Estimated soil erosion for untilled soil = $200 \times 0.17 \times 0.379 \times 0.011 = 0.142$ tons/acre/year.

Estimated soil erosion for tilled soil = $200 \times 0.17 \times 0.379 \times 0.017 = 0.22$ tons/acre/year.

Conclusion and Key Takeaways

In this example, the tilled area had about 55% higher soil loss than the untilled area. This example shows how soil disturbance can increase erosion risk. Areas with heavy disturbance, such as roads, skid trails, and locations where topsoil has been removed, are especially vulnerable and should be carefully managed to reduce additional soil loss.

Estimating and addressing soil erosion is a vital part of long-term forest soil management. With a clear understanding of erosion rates on a harvest site, effective steps can be taken to reduce soil loss. Implementing appropriate management strategies is essential to mitigate risks and protect soil health, water quality, and surrounding ecosystems. These strategies may include planting cover crops, installing erosion control structures, creating water diversion devices, or reducing the intensity of logging and other land management activities that contribute to erosion.

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Sources

Dissemeyer, G., & Foster, G. (1984). *A guide for predicting sheet and rill erosion on forest land. USDA Forest Service, State Priv. For. Tech. Publ*.

Parajuli, M., Gallagher, T., Cristan, R., Daniel, M. J., Mitchell, D., McDonald, T., Rijal, A., & Zheng, J. (2024). Postharvest evaluations of soil erosion, ground cover, and best management practice implementation on integrated biomass and conventional clearcut harvest sites. *Forest Ecology and Management*, *566*, 122041.

Parajuli, M., Hiesl, P., Hagan, D., & Khanal, P. (2022). Logging operations and soil compaction. *Land-Grant Press: Clemson, SC, USA*.

Picchio, R., Jourgholami, M., & Zenner, E. K. (2021). Effects of forest harvesting on water and sediment yields: A review toward better mitigation and rehabilitation strategies. *Current Forestry Reports*, *7*(4), 214-229.

Rijal, A., Cristan, R., Gallagher, T., Narine, L. L., & Parajuli, M. (2023). Evaluating the feasibility and potential of unmanned aerial vehicles to monitor implementation of forestry best management practices in the coastal plain of the southeastern United States. *Forest Ecology and Management*, *545*, 121280.