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USDA LTAR Common Experiment measurement: Sediment flux

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Abstract

Wind erosion from agroecosystems can harm ecosystem functions, environmental quality, and human health. Wind erosion can also lead to reduced economic returns through damage to property and compensatory increases in supplemental fertility. Field measurements of wind erosion are resource- and time-intensive, necessitating using predictive models across different land uses. Here, we briefly describe field measurements necessary for generating sediment flux estimates using the Aeolian EROsion (AERO) model. This model requires data on soil surface texture, ground and foliar cover, canopy height, and vegetation canopy gap lengths. Methods align with those used by the National Wind Erosion Research Network, which aims to develop decision-support tools for managing wind erosion and its impacts.

Overview

1 Sediment flux estimates from the AERO model require three types of inputs for each monitoring location: 1) soil surface texture, 2) ground and foliar cover and vegetation height measurements, and 3) canopy gap observations (Edwards et al., 2022).

The particle size distribution (PSD) of near-surface (0-1 cm) soil provides information to estimate the threshold shear velocity for aeolian sediment transport initiation. Assessments are made at field scale using a stratified random sampling design using composite samples from 0 to 1 cm depth. Soil PSDs are estimated for minimally and fully dispersed samples from 0.4 to 2000 µm using a Beckman Coulter LS 13 320 laser diffraction particle sizer or comparable instrument. Details are outlined by Edwards et al. (2022) and adapted in summary form below.

Ground and foliar cover and height

The cover, height, and distribution of vegetation affect the wind shear stress (horizontal force at the surface) that can erode soil surfaces. Accordingly, assessments of vegetation attributes are important for understanding their effectiveness in reducing wind erosion. Ground and foliar measurements using the line-point intercept (LPI) method are conducted along three (3) transects, which are 100 meters long across a representative 1 ha site within a field. Plots can be scaled to smaller areas, although it is important to ensure that transect lengths and LPI and vegetation height sampling intervals appropriately describe the spatial variability of ground cover elements. A link to instructional videos for establishing transects and understanding the LPI method is provided below. Details are outlined by Herrick et al. (2018), Webb et al. (2015), and Edwards et al. (2022) and adapted in summary form below.

Canopy gap observations

Canopy gap observations provide insight into the distribution and horizontal structure of the plant community. Make observations along the same transects used for other vegetation assessments. A link to an instructional video for the canopy gap intercept method is provided below. Details are outlined by Herrick et al. (2018), Webb et al. (2015), and Edwards et al. (2022) and adapted in summary form below.

Always conduct bare soil, ground cover, and canopy height and gap measurements at project initiation. The frequency of subsequent measurements will depend on the temporal dynamics of vegetation cover and structure. Measurement frequency for croplands should capture changes in biomass throughout the growing season and in response to management practices and field activities (e.g., tillage, planting, harvest, cover crop interseeding, residue removal, etc.). Moreover, measurements should be conducted at cropland sites during fallow phases to

capture changes in ground cover. For rangelands, measurement frequency should capture seasonal vegetation cover and structure changes. Vegetation assessment times should be flexible to account for inter-annual variability in production and management.

Soil characteristics

2 Identify a representative plot area measuring 100m x 100m in size.

3 Partition the site into nine equivalently sized areas using a 3 × 3 grid.

4 Randomly assign three sampling locations within each grid cell to Sample Groups 1, 2, and 3 (Fig. 1).

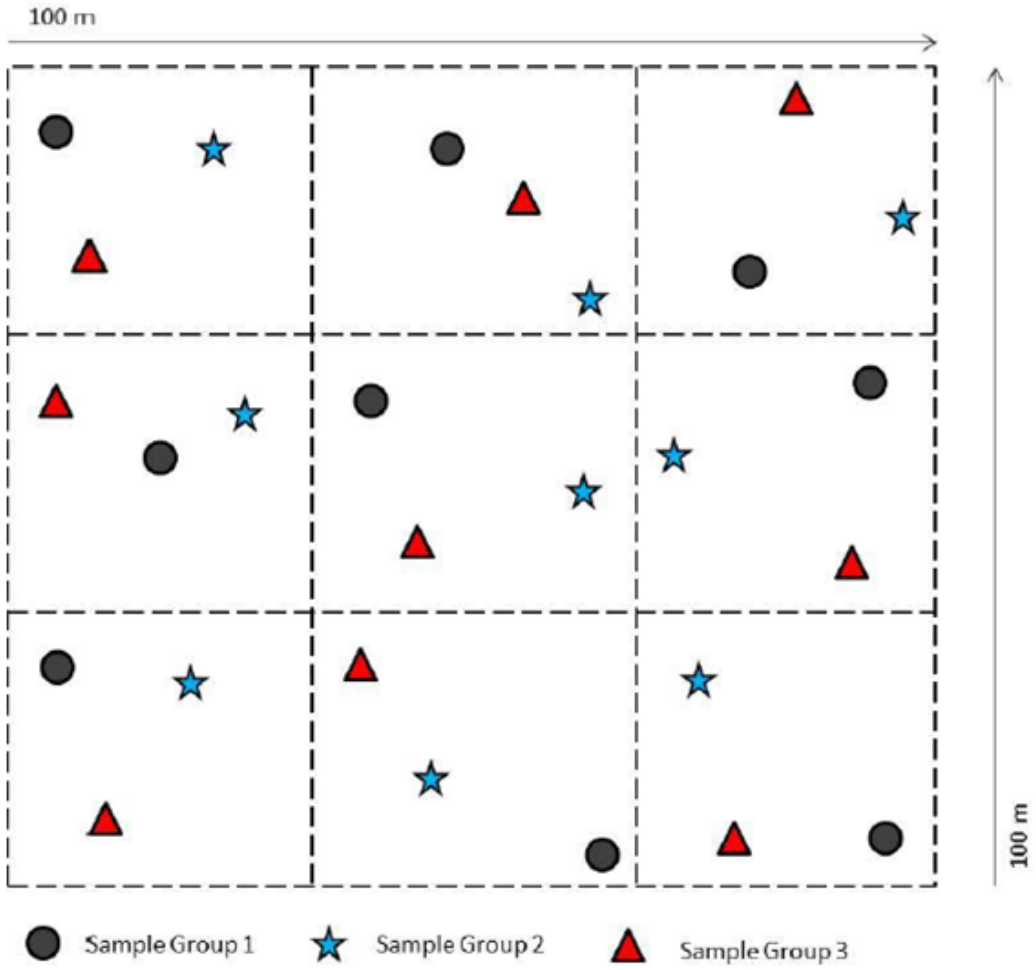

Fig. 1. Soil sampling design diagram (from Webb et al., 2015).

5 Use a flat-bottomed aggregate stability scoop to collect ~250 g of soil from the 0-1 cm depth at each location. Combine samples across Sample Groups to form three composite samples.

6 Air-dry samples at room temperature for a minimum of 1 week before conducting lab analyses.

7 Hand sieve samples to remove rock fragments >2 mm, plus to remove litter that is >1 mm wide and/or >2 cm long.

8 Measure soil PSDs using a laser diffraction particle sizer.

> **Note**
>
> Measure soil PSD at project initiation. Although a single baseline measurement will suffice at most sites, subsequent measurements may be necessary if sites are experiencing considerable erosion/deposition.

Establish transects

9 Assess ground and foliar cover on three (3) 100 m transects.

10 Transects should follow bearings of 0°, 60°, and 120°, intersecting at the center of the site (Fig. 2).

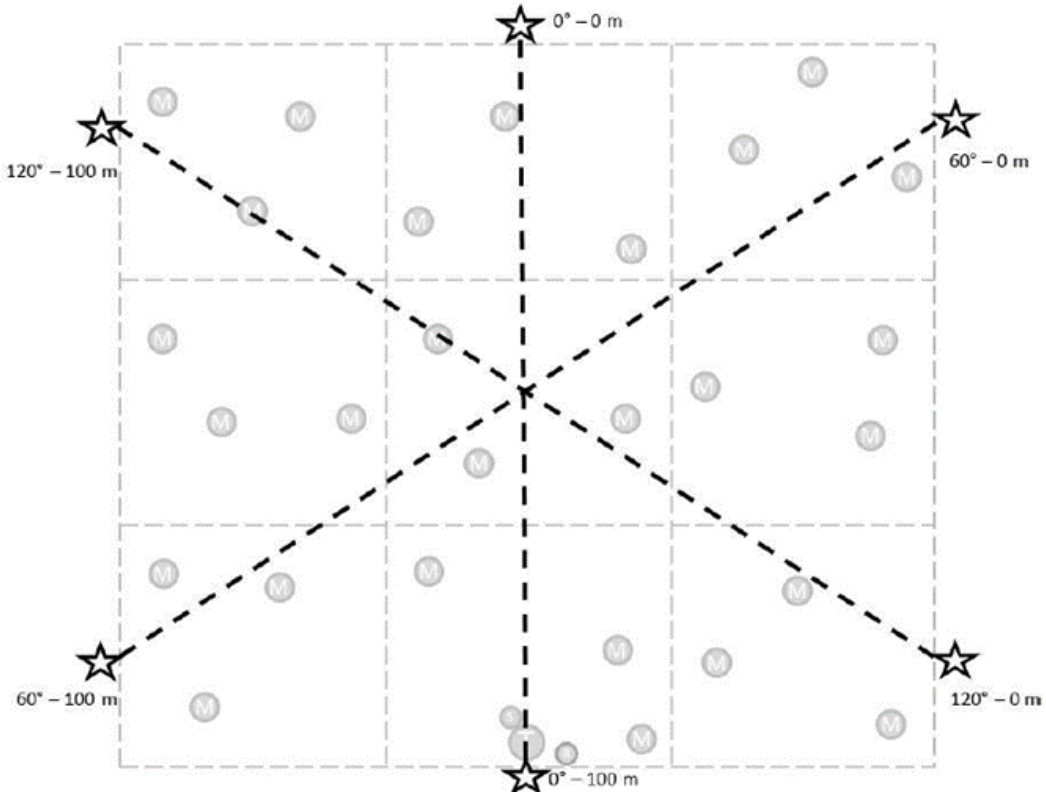

Fig. 2. Proposed orientation of transects for ground and foliar measurements (from Webb et al., 2015).

11 Mark transect start and end points to ensure transect lines are in the same place in subsequent measurements.

12 It is acceptable if an entire transect falls in a crop interrow.

Bare soil

13 Make LPI measurements at a sampling interval of 0.25 m (maximum) for bare soil and ground cover.

14 Bare soil represents a 'hit' that contacts soil (< 2 mm), loose erodible soil (if the category is recorded), aggregate soil (> 2 mm), or physical crust.

15 Points with plant cover (which includes both foliar and basal elements) or litter over soil do not count as bare soil. Also, rock fragments do not count as bare soil.

Ground cover

16 Ground cover comprises all non-soil elements (e.g., vegetation, litter, rocks, and biocrust).

17 Ground cover and bare soil may not sum to 100% across a single transect as this depends on how indicators are calculated. It is best if ground cover indicators are calculated using the terradactyl R package described by McCord et al. 2022.

Vegetation canopy height

18 Measurements of vegetation canopy height are conducted concurrently with bare soil and ground cover measurements.

19 Record canopy height (cm) as the maximum height of any vegetation element (leaf or stem) within a 15 cm radius every 2 m along each transect. The plant does not have to root within the 15 cm radius.

20 If no vegetation is present, record the height as zero.

20.1
- Canopy gaps are interrupted by any plant species.
- Canopy occurs any time 50% of any 3 cm segment of tape edge intercepts live or dead plant canopy, based on a vertical projection from the canopy to the ground.
- Record canopy gap lengths ≥5 cm along each transect.

Illustrative media and data recording sheets

21 Instructional videos for vegetation assessments are available at *The Landscape Toolbox: Training Videos* (https://landscapetoolbox.org/training-videos)

- Establish a Transect
- Line-Point Intercept
- Canopy Gap Intercept

Data recording sheets in PDF and Excel formats are available at https://winderosionnetwork.org/documents

- Cropland Management Recording Sheet
- Rangeland Management Recording Sheet
- Line-Point Intercept and Vegetation Height Recording Sheet
- Vegetation Canopy Gap Recording Sheet

Recommendations for data collection

22 Table 1. Summary of recommendations for measuring Aeolian Erosion (AERO) model inputs for sediment flux estimation.

	A	B	C	D
	Attribute	**Preferred**	**Minimum**	**Comments**
	Spatial scale	Field		Methodology applicable to field scale only
	Soil assessments	Recurring measurement	One measurement at project initiation	The frequency of soil particle size distribution measurement depends on the extent of soil erosion/deposition at the site
	Vegetation assessments	Quarterly	Annually	Vegetation assessments may be restricted to spring, summer, and fall at locations with snow cover during the winter
	Covariate metrics	Oriented roughness		Conducted concurrently with vegetation assessments
	Other	Management records		Record equipment changeouts or issues, plus planting and harvesting activities

Additional considerations

23 Sites that belong to the National Wind Erosion Research Network should follow the expanded assessment protocols outlined in Webb et al. (2015). Supplementary resources are available at **https://winderosionnetwork.org/**

Recorded data should be entered into a Database for Inventory, Monitoring, and Assessment and sent to Landscape Data Commons or NWERN personnel to ingest and process the data (McCord et al., 2022).

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