A NATIONAL WIND EROSION MONITORING NETWORK TO SUPPORT AN ALL-LANDS WIND EROSION MODEL

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Motivation: An All-Lands Wind Erosion Model

Public concern about wind erosion in the United States is increasing. This concern has arisen as a consequence of changing and intensifying land use pressures, which can lead to increased soil loss and dust emissions and impacts on biogeochemical cycles, agricultural productivity and human health. However, there are few available tools to support improved management.

To address the issue a new wind erosion model is being developed to assess net wind erosion across all land uses, including rangelands and croplands. The model development, led by the United States Department of Agriculture (USDA), will provide a tool for land managers and scientists to evaluate the impacts of land management and land use change on rates of wind erosion and dust emission. The model will provide estimates of net horizontal and vertical aeolian sediment fluxes, enabling assessments of management impacts on wind erosion from the plot to regional scales.

Objective

A significant constraint to the development of wind erosion models is limited and non-standard data for model calibration and testing. In response, a National Wind Erosion Monitoring Network is being established. The Network is a partnership between the USDA Long Term Agro-ecosystem Research (LTAR) Network, the Bureau of Land Management (BLM) and the Department of Defense (DoD).

The objective of the Network is to develop a national (US) dataset of standardized measurements of wind erosion and its controlling factors needed for the calibration, testing and application of an all-lands wind erosion model.

Development of a Standard Methods Protocol

A standard methods protocol is being developed to direct the measurement of wind erosion and its controlling factors at Network sites. The document provides a set of core methods that will be used at all Network sites, in rangelands and croplands, and a set of supplementary methods that can be used to collect additional data in support of soil erodibility assessments and the measurement of sediment transport rates.

The core methods include protocols for measuring:

- Soil surface characteristics: texture analysis, physical and biological crust cover
- Vegetation attributes: fractional cover by species, canopy gap size distribution, vegetation height
- Meteorological controls: wind velocity and temperature profiles, saltation counts, precipitation, relative humidity, aerodynamic roughness height and threshold shear velocity
- Horizontal sediment transport rates, including net horizontal flux and directional sediment flux
- Vertical sediment flux, including dust deposition flux, will be measured on an event basis at some sites

The standard methods protocol will be open access and available through:
http:/www.jornada.nmsu.edu/monit-assess/manuals

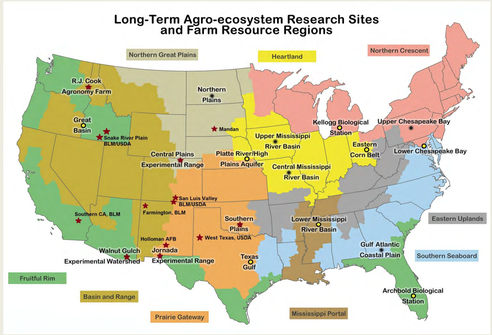
National Wind Erosion Monitoring Network

Site Locations

Network calibration sites will be established across the western United States at locations that represent the diversity of soils, vegetation, climate and land use and management practices in areas susceptible to wind erosion.

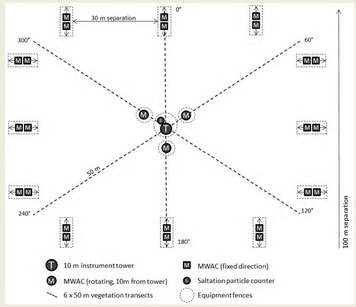
It is expected that the Network will initially involve 9 USDA stations, 4 BLM stations and 1 DoD station (14 total).

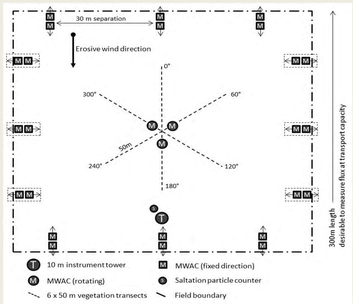
Figure right shows prospective Network locations, marked with a red star.



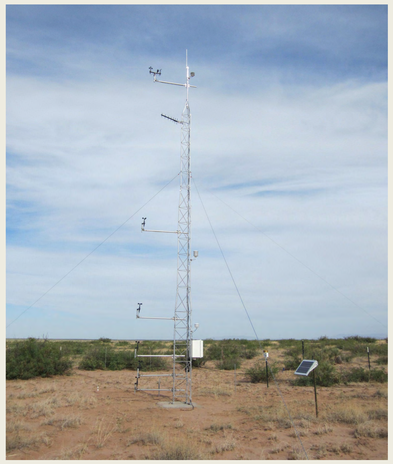
Site Design

A standard layout will be used that is consistent for rangeland (left) and cropland (right) sites. The equipment layout will enable quantification of net horizontal sediment flux, vegetation attributes and meteorological conditions controlling transport.





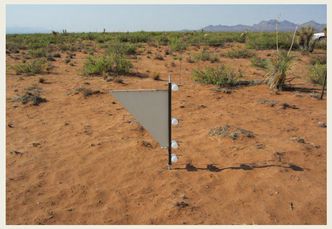
Equipment at Network Sites



Each Network site will be instrumented with sensors and samplers to measure the meteorological controls on sediment transport, and sediment transport rates.

A 10 m instrument tower (shown left) will be located in the centre of rangeland sites, or at the downwind edge of cropland sites. The tower will provide a platform to measure the wind velocity profile (6 heights), air temperature profile (3 heights), relative humidity, precipitation, and saltating particle counts (Sensit).

Data will be measured at a frequency of 1 Hz and logged at 1 min interval before transmission via mobile data network to a centralized database maintained at the Jornada Experimental Range in Las Cruces, NM.



The frequency and magnitude of sediment transport will be measured at sites using a saltation sensor (left) and 27 MWAC sediment samplers (below) to a height of 1 m.

Each site will have a set of 3 rotating MWAC samplers and 24 fixed-direction MWAC samplers to provide estimates of the horizontal sediment mass flux and net horizontal sediment mass flux over a site.

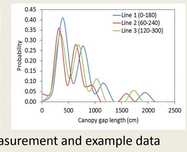
At select sites Frisbee-type dust deposition traps will be used to measure the vertical dust deposition flux and a vertical array of three DustTrak DRX samplers will be used to measure a profile of the vertical sediment mass flux <10 µm during transport events.

Sampling – Vegetation, Soil and Management

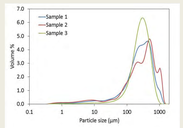
Data on site management practices, vegetation and soil properties will be collected to describe the soil erodibility and surface roughness at sites.

Measurements of the fractional cover of vegetation and soil crusts, the canopy gap size distribution, and canopy height will be made along three 100 m transects.

The vegetation and soils data can be used to parameterize wind erosion models for calibration and testing.



Vegetation canopy gap measurement and example data



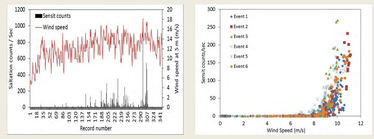
Soil particle size distributions and variable surface condition

Data and Model

Data collected at Network sites will be transmitted and stored centrally at the Jornada Experimental Range.

Data will then be processed to evaluate dynamic soil erodibility (u_{*t}) and aerodynamic roughness (z_0) changes at the sites and prepared for input to model calibration and testing procedures.

These procedures will enable the development of a open-source all-lands wind erosion model and management decision support tools.



Example sediment transport and wind speed data

Test web application for an online wind erosion model

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