

# The Equation of Dust: How Vegetation Characteristics Influence Dry-Land Dust Emissions

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## OVERVIEW

- Wind erosion and associated dust emissions play a fundamental role in many ecological processes and affect human health.
- From an ecosystem perspective, dust capture by shrubs may contribute significantly to the well-known 'island of fertility' phenomenon, whereby soils associated with shrubs are enriched in nutrients relative to surrounding soils.
- Changes in climate and intensification of land use will likely lead to increased erosion and dust emissions.
- It will, therefore, be important that environmental scientists, land managers, and policy makers understand how these are influenced by land cover.



## FIELD METHODS

- Mesquite (*Prosopis velutina*) shrubs (n=6; Fig. 1) were instrumented with modified Wilson and Cooke (MWAC) dust samplers from January 2011 to January 2012.
- MWAC samplers (Fig. 2) facing outward were placed around the shrub canopy perimeter at each of the cardinal directions at heights of 0.06, 0.25, 0.50, and 1.00 m.
- Dust accumulating in the MWAC samplers was collected every 1-2 months depending on wind conditions.
- The dust in each sampler was weighed, and the mass summed across all heights and placement locations.



Fig. 2. Close-up of an MWAC sampler.



Fig. 3. Pan-sharpened Quickbird imagery of study area.

## RESULTS

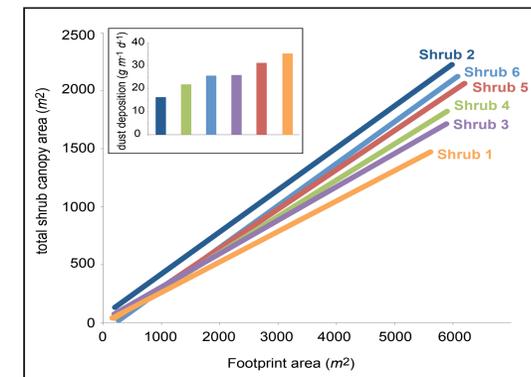


Fig. 5. Linear regression of total shrub canopy area vs. footprint area for instrumented shrubs. Inset: Total dust deposition per shrub

- Total shrub canopy area increased linearly with increase in footprint area for each shrub
- Shrub 2 had the highest total neighborhood shrub canopy area and lowest dust deposition at all footprint sizes
- Shrub 1 had the lowest total neighborhood shrub canopy area and the highest dust deposition

## OBJECTIVES

- Quantify the extent to which variation in dust capture by a shrub is dependent on the structure of the vegetation in its neighborhood.
- Determine the spatial scale at which vegetation structure in a semi-arid shrub savanna influences soil movement within a landscape.



Fig. 1. Mesquite tree at the Santa Rita Experimental range instrumented with vertical array of Wilson-Cooke Modified Samplers at four heights

## LABORATORY METHODS

- Shrub canopies were digitized from pan-sharpened Quickbird Imagery (0.61 m pixel resolution; Fig. 3) from May 2008 in ArcGIS 10.
- Total shrub canopy area within circular footprints (radii ranging from 5 to 40 m) around the six targeted shrubs were then computed (Fig. 4).
- The relationship between total shrub canopy area ( $m^2$ ) and soil mass in MWAC samplers was then evaluated for each footprint area.

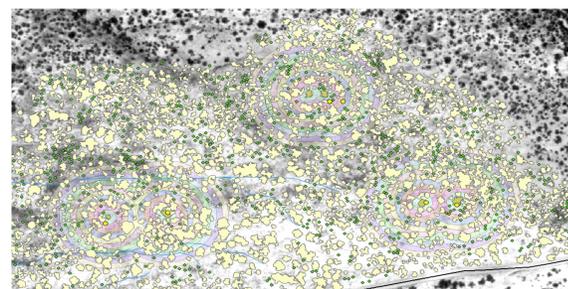


Fig. 4. Quickbird image showing shrub canopies (yellow polygons) and footprints of various sizes (concentric rings) around instrumented shrubs

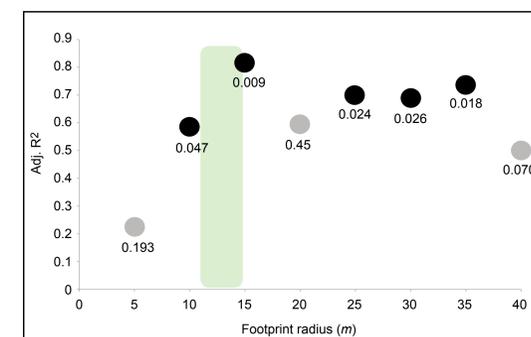


Fig. 6. Model results showing the spatial scales (footprint radii) at which variation in dust accumulation can be explained by total shrub canopy area. P-value is listed below each point (points representing significant models are in black).

- A linear regression of dust accumulation vs. total shrub canopy area within each buffer was conducted for each footprint radius (n=8)
- Total shrub canopy area explained a significant amount of variance (60-80%) in dust accumulation for five footprint radii (shown in black)
- Comparison of Adj. R2 values suggests that a buffer radius of 10-15 m (highlighted in green) is ideal for predicting dust deposition in this system

## CONCLUSIONS

- Dust accumulation ranged from 4.1 to 8.9  $g\ m^{-1}\ d^{-1}$  for the 6 shrubs monitored.
- A significant fraction of the variance in rates of dust accumulation by shrubs (60 to 80%) was explained by neighborhood vegetation structure.
- Accounting for vegetation structure within a 10-15 m radius of the targeted shrubs explained the greatest amount of variance in dust accumulations. There was little or no added benefit of accounting for vegetation structure over smaller or larger areas.

## NEXT STEPS

- Analyze data with respect to (a) prevailing wind direction and (b) time of year.
- Include shrub height as well as total canopy area in the footprint analysis.