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J. E. Herrick
U.S. Department of Agriculture

D. P. C. Peters
U.S. Department of Agriculture

Brandon T. Bestelmeyer
U.S. Department of Agriculture

G. S. Okin
University of California, Los Angeles

N. K. Hansen
U.S. Department of Agriculture

See next page for additional authors

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Presenter Information

J. E. Herrick, D. P. C. Peters, Brandon T. Bestelmeyer, G. S. Okin, N. K. Hansen, and Kris M. Havstad

Predicting soil erosion and deposition effects on plant establishment : a key to increasing restoration success

J . E . Herrick¹ , D . P . C . Peters¹ , B . T . Bestelmeyer¹ , G . S . Okin² , N . K . Hansen¹ and K . M . Havstad¹

¹USDA-ARS Jornada Range , Las Cruces , NM 88003-8003 , USA , jherrick@nmsu.edu , ²Dept . of Geography , UCLA , Los Angeles , CA , 90095 , USA

Key words : restoration , land degradation , soil erosion , seedling establishment

Introduction Land degradation is frequently associated with soil erosion and deposition . This can result in significant modification of the soil profile , including changes in soil surface texture and structure . Soil surface texture and structure affect plant water availability through their effects on infiltration rate and plant available water holding capacity . Plants in arid and semi-arid environments are particularly susceptible to desiccation during establishment . Consequently , changes to soil surface texture , structure or depth can affect establishment , as well as the productivity of the established plant community . In extreme cases , re-establishment of the original plant community may be impossible , even with significant external inputs (Bestelmeyer et al . , In Press) .

While the negative impacts of soil erosion are widely recognized , the potentially positive and negative effects of deposition on restoration potential are often ignored . Large areas of the world are affected by soil deposition . The most visible examples are associated with dune systems , but significant soil deposition can occur without dune formation downslope or down wind of cultivated fields , roads and other disturbances .

Where all other factors are equal , deposition of small quantities (several centimeters) of coarse-textured material on top of fine-textured material should increase infiltration and surface water holding capacity while reducing evaporative losses . Exposure of a fine-textured layer by erosion of coarse-textured material should have the opposite effect . The effects should depend on the depth of soil added or removed , and on initial soil profile characteristics . Soil surface structure degradation or the addition of degraded soil tends to reduce both infiltration and water holding capacity .

Materials and methods A series of field studies and modeling exercises are currently being completed at the USDA-ARS Jornada Experimental Range , located in the northern Chihuahuan Desert in south-central New Mexico , USA to examine the effects of soil erosion and deposition on plant establishment . This area receives approximately 245 mm of precipitation , over half of which arrives in convective storms during the growing season . Several areas of fine textured soils on the Jornada are being buried by sand from upwind areas . This study design exploits these landscape dynamics .

Results Examples of the effects of a change in soil surface texture on soil water availability are shown in Table 1 . As predicted , model results showed that sand addition to the soil surface affected establishment differently depending on the amount of sand added and the initial soil texture . Field studies of areas where sand deposition has been occurring during past several decades indicate that plant community dynamics are controlled by a number of different factors in addition to sand deposition , and that feedbacks with the plant community itself are likely to be important .

Table 1 Sample effects of surface texture change from loam to sand based on agricultural soils (Saxton and Rawls 2007) . Input texture and bulk density data are from a depositional site on the Jornada . Effects on rangeland soils may be different due to differences in soil structure , but general patterns should be similar .

Texture	Sand	Silt	Clay	Bulk	SOM	Available	Available Water	Sat . Hydr .
				Density	(est .)	Water	Top 10cm	Cond .
				%				mm/hr
Loam	39	34	27	1.36	1.0	13	13	15
Sand	90	5	5	1.51	0.1	4	4	126
Change	+51	-29	-22	+0.15	(-0.9)	-9	-9	+111

Conclusions Careful characterization of site conditions and soil profile characteristics should be completed before restoration . At a minimum , changes in soil water characteristics should be predicted using texture relationships .

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