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

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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 Density	SOM (est .)	Available Water	Available Water Top 10cm	Sat . Hydr . Cond .
	%						mm	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 .

References

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