Land Imprinting Restoration:
Hydrology and Ecology

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Restoration Hydrology

As land desertification or land degradation proceeds, surface water hydrology changes in such a way that the land and its plant communities slowly desiccate or dry out. This dehydration of the landscape often causes a gradual shift toward more xeric or weedy plant species that can better cope with the drier habitat. Land desertification or the drying process occurs inn climates ranging from humid to arid and is triggered by both human and natural land disturbances such as overgrazing and drought.

As desertification proceeds and the soil gradually dehydrates, surface water hydrology is changed in a number of ways. The soil surface becomes increasingly barren, losing its protective cover of vegetation. As a result splash and sheet erosion increase, thereby (*because of*) hydraulic smoothing and plugging of surface connected macropores. Because of the smoothing and sealing (crusting) of the soil surface, water infiltration greatly decelerates while runoff and gulley erosion accelerate Gulley erosion further increases the hydraulic smoothness of the landscape, increasing surface runoff and downslope flash flooding. Much of the rainwater that does infiltrate penetrates only to shallow depths and is soon lost by evaporation from the barren surface.

The cumulative effect of the foregoing process is the drying of the landscape and the further loss of vegetation and, in turn, the further acceleration of the desertifying process. Thus desertification becomes a vicious circle with strong feedback loops. At the extreme, desertification leads to the total extermination of all above and belowground life, a phenomenon prevailing especially in arid lands.

Reversing the insidious desertification process requires application of *restoration hydrology*, especially at the soil surface. Hydraulic roughness and macroporosity must be restored at the soil surface to regain the high infiltration rates of the undesertified land.

After the soil is rehydrated by the accelerated infiltration, plant communities can then be re-established to reverse desertification permanently or until another land disturbance comes along. **This is the strategy of Land Imprinting,** a new no-till method under development for the past quarter century that is based upon many years of infiltration control research. Imprinting effectively restores hydraulic roughness and macroporosity to the soil surface to, in turn, restore high infiltration. Combining seeding and inoculating with imprinting restores both the ***hydrology*** and ***ecology*** of degraded lands.

Restoration Ecology

As suggested in the foregoing section restoration of surface water hydrology is the first step in reversing land desertification or the dehydration of degraded land. The cultural practice known as Land Imprinting roughens and opens a smooth-sealed desertified surface to allow the soil to rehydrate from rainfall. Rainwater is held in place to recharge the soil-water reservoir and subsequently the groundwater aquifer. Once the soil is rehydrated, ecosystems of plants and animals can be restored or created. Ecological restoration begins by selecting an appropriate ecomix of plant seeds and soil organisms to be applied at the time the land is imprinted for

hydrologic restoration. Thus hydrologic and ecologic restoration can be accomplished simultaneously if the ecomix applicator is mounted above the imprinting roller. In practice, the compound application and imprinting machine is a very simple and durable device having only two moving parts- the ecomix agitator and the imprinting roller.

The seed mix usually contains early, mid and late successional species. Generally, the early seral plants are short growing, short lived annuals, whereas the late seral species are tall-growing long-lived perennials with the mid species being intermediate in height and longevity. A good seed mix usually has 10 to 15 species and is applied at 10 to 15 pounds of pure live seed per acre. Where desertification is advanced, one-third of the seed mix should be composed of early successional species to pave the way for later species by rebuilding soil structure and stability. Cool season annual grasses are excellent for stabilizing imprints to maintain their physical function for up to five years. The early successional species serve in the roles of cover, nurse, green manure and mulch crops to aid in the establishment of later successional species. They also provide ecological control of weedy species in the soil seed bank through competition for light and moisture thereby accelerating natural succession.

Imprints function physically by funneling resources for seed germination and by shielding seedlings for successful establishment. The V-shaped imprints funnel seed, water, plant litter and splash eroded topsoil together into the bottom of the Vee where they can work in concert to germinate seeds and establish seedlings. Tender young seedlings emerging in the bottom of the V-shaped imprints, are protected from the desiccating winds and hot sunlight of the macroclimate above. The moist, shady microclimate of the Vee bottom allows young seedlings to sink their roots deeply before their tops emerge into the harsh macroclimate.

The imprint functions just described are repeated over and over again for a period up to 5 years if necessary because seeds are initially imbedded all over the imprint including the sidewalls and the crest of the imprint from which more seed can be washed into the bottom of the imprint with each successive storm event. Thus imprinter seeding provides a wide time window of opportunity for successful plant community establishment. This function of imprints is especially important in arid climates with inherently low and infrequent precipitation and where a single event is seldom large enough to establish seeded vegetation.

Finally, properly designed seeding and inoculating land imprinters can, in a single low-cost operation, reverse the land desertification process through hydrologic and ecologic restoration at the soil surface and beneath it. Such imprinters have already been successfully tested on ten of thousands of acres of degraded land in the arid regions of Arizona and California during the past quarter century.