Chapter 9
Rapid Evaluation of Arid Lands (REAL): A Methodology

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ABSTRACT

Management of desert grasslands requires rapid, low technology, coarse assessment methods that provide a triage-like prioritization for the manager. Such approaches necessitate the ability to quickly and effectively identify coarse-scale plant communities that provide guidance for this prioritization. Complex, computer intensive digital image classification of Landsat TM data, while marginally successful, requires time, equipment, and expertise not always available in such environments. This study identifies landform boundaries in the Armendaris Ranch, New Mexico by visual inspection of Landsat-7 Enhanced Thematic Mapper imagery and topographic maps using traditional photoreconnaissance techniques. Employing predetermined hierarchical landform classifications, it was possible to map plant communities using ecological relationships that exist between the general physiographic and vegetation settings in the area and representative geomorphic landform-mapping units. The authors' field work verified the plant community map using a random walk approach and visual inspection. This synthetic expert opinion-based approach proved successful and is repeatable in other arid rangeland settings.

DOI: 10.4018/978-1-4666-1951-7.ch009

INTRODUCTION

Worldwide, desert grasslands are undergoing change from a relatively uniform, non-fragmented structure to a more patch-dominated pattern (Schlesinger et al., 1990). This fragmentation results both in negative economic conditions where livestock forage is limited, and in substantial ecological consequences such as more heterogeneous concentrations of nutrients, moisture, and biomass, along with attendant changes in species composition (Whitford, 2002). Many believe that overgrazing accounts for substantial desert landscape modification, although climate change, fire history, and anthropogenic activity are also seen as partial causes of such changes (Buffington & Herbel, 1965; Grover & Musick, 1990; Whitford, 2002; Zonn, 1988). There is also increasing evidence that geomorphometric terrain variables (Franklin, 1987), especially reflected in soil and sediment properties, greatly modify the degree to which these factors influence desert vegetation (Schlesinger et al., 1990).

The concept that geomorphic landforms can have a significant effect on natural desert vegetation cover has been proposed and demonstrated by several workers including Buffington and Herbel (1965), Cole and Brown (1976), McAuliffe (1994, 1995), Montaña and Greig-Smith (1990), Parker (1991, 1995), Schlesinger et al. (1990), Sharma (1993), Valverde et al. (1996), Wondzell, Cunningham and Brachelet (1987, 1996), and Zimmerman (1969). Parker and Bendix (1996) provided a comprehensive review of geomorphic influences on vegetation pattern, or what has been called "physiographic plant geography" (Zimmerman & Thom, 1982). Most studies emphasized either spatial patterns (Satterwhite & Ehlen, 1982; Smith, Adams, & Gillespie, 1990), or the underlying processes creating those patterns (Glaser, Janssens, & Siegel, 1990; Malanson, 1993; Swanson, Caine, & Woodmansee, 1988).

Distribution of sediments across the landscape, as a result of geomorphic processes, affects physical and chemical surface properties, pedogenesis, and the movement of water and nutrients (Birkeland, 1990; Bowers & Lowe, 1986; Gile & Grossman, 1979; Graf, 1988; Key, Thompson, & Van Hoogenstyn, 1984; Malanson, 1993; McAuliffe, 1994; Parker, 1995; Shreve, 1964; Philips & MacMahon, 1978; Yang & Lowe 1956). The contributions of varying geologic parent material into the sediment budget also affect the types of sediments produced by weathering (McAuliffe, 1994; Parker, 1995; Shreve, 1964). With geomorphic landforms, therefore, comes a suite of related attributes in addition to such basic characteristics as topographic position, elevation, slope angle, and aspect (Davis & Goetz, 1990; Franklin, 1987; Satterwhite, Rice, & Shipman, 1984; Shasby & Carneggie, 1987; Zevenbergen & Thorne, 1987). All of these attributes, in turn, affect microclimate and hydrologic processes that profoundly influence plant distribution (Parker & Bendix, 1996; Swanson, Caine, & Woodmansee, 1988). This complexity, particularly in the context of arid and semi-arid alluvial fans, has been noted by several workers in North American hot deserts (Burk & Dick-Peddie, 1973; Cunningham & Burk, 1973; Denny, 1965; Dorn, 1988; Graf, 1988; Harvey & Wells, 1994; Mabbutt, 1977; McAuliffe, 1994; McFadden, Ritter, & Wells, 1989; Parker, 1995; Rachocki, 1981; Stein & Ludwig, 1979; Wierenga et al., 1987).

Buffington and Herbel (1965) and Wondzell, Cunningham, and Bachelet (1987, 1996) offer theoretical and empirical examples of geomorphology-vegetation relationships in the Chihuahuan Desert of New Mexico. Field research involving the use of transects of soils, vegetation, and geomorphological position in the Chihuahuan and Sonoran deserts also provides support for presuming such relationships (Wierenga et al., 1987; Cornelius et al., 1991). While these approaches are invaluable for the insights they provide, transects and point sampling techniques are limited in spatial extent, preventing the direct transference of results to larger regions for impact