Chapter 14

COMPARING LANDSCAPE AND INFRASTRUCTURAL HETEROGENEITY WITHIN AND BETWEEN ECOSYSTEMS

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Ecological research throughout much of the last century focused upon manipulative experiments on areas of a few square meters or less (Kareiva and Andersen 1988). The last quarter of the century saw the development of landscape ecology and the emergence of macroecology as a bonafide method of research and discovery (e.g., Brown 1995, Blackburn and Gaston 2002). Geographical and human-ecological research increasingly has successfully integrated human populations and their behaviors into analyses of land use change (Rindfuss and Stern 1998). Today, readily available broad-scale data, such as satellite images and global spatial databases, make comparing attributes of landscapes and the people who inhabit them uniform, thorough, repeatable, and relatively inexpensive (Roughgarden et al. 1991).

Disturbing trends in rangelands throughout the world make the need for comparisons across regions particularly pressing. Two-hundred million or more people derive a significant portion of their income from raising livestock on rangelands (De Haan et al. 1997) that comprise about 25% of the landscapes of the world (Groombridge 1992). Land use is diversifying and intensifying, including the conversion of marginally productive lands into areas of cultivation (FAO 2001). On many of these lands pastoral people are being sedentarized and grazing areas used by livestock and wildlife are being fragmented or subdivided (defined in Hobbs et al., Chapter 2). Further, a feedback can exist where, for example, conversion and

K. A. Galvin et al. (eds.), Fragmentation in Semi-Arid and Arid Landscapes: Consequences for Human and Natural Systems, 341–367.

fragmentation can cause declines in human food security, and these stressors lead residents to further fragment their land and intensify use. In other already fragmented systems, producers are now trying to re-extensify their access to lands, having identified economic and ecological costs associated with intensive livestock raising on small areas of land.

Dominant policy narratives surrounding pastoralism assume that subsistence-based animal production systems should modernize toward intensive production methods. A subsequent assumption is that natural capital resources are perfectly substitutable by economic inputs (Prugh 1999). In the context of this volume, natural capital is represented by the resource connectivity and spatio-temporal heterogeneity that characterizes unfragmented rangeland systems. Consequently, the assumption is that with the addition of economic inputs, a low-input, unfragmented and extensive livestock production system will smoothly transition into a capital intensive, input-dependent livestock production system functioning at a small scale, with associated benefits for humans, livestock, ecosystems, and national economies. However, the transition from extensive to intensive livestock systems is not free, nor has it been smooth in most cases. The inputs required to compensate for the natural capital lost through fragmentation are expensive and not readily available to many rural producers. Also, the ability of governments, especially in the developing world, to provide access to compensatory factors under market liberalism and structural adjustment programs is questionable (ADF 2003, Njenga and Davis 2003). This leaves pastoral producers in a difficult position, as they are pushed by policies and by the need to subdivide and intensify production on one hand, but are left without access to the means to bridge the productivity gap on the other. The difficulties inherent in making fragmented rangelands economically viable are illustrated by the Australian and Great Plains case studies (Stokes et al., Chapter 4; Lackett and Galvin, Chapter 5), systems in which producers are moving to re-aggregate their productive parcels, *in spite of* having high relative access to productive inputs, infrastructure services, and governmental support mechanisms that should compensate producers for losses in access to spatial scale.

Theory suggests and research has shown that the quantity of external inputs needed to support ecological and productive systems in fragmented landscapes is inversely related to the landscape and infrastructural heterogeneity (defined below) of the ecosystem (Ritchie and Olff 1999, Doncaster 2001, Ash et al. 2004, Boone and Hobbs 2004, Boone et al. 2005, Thornton et al. 2006). Lands that are vegetatively diverse provide more forage choices for livestock and wildlife; ample food, water, and habitat are more likely to