Geophysical Research Abstracts,
Vol. 11, EGU2009-1200, 2009
EGU General Assembly 2009

Spatial vegetation patterns and desertification

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Arid ecosystems are amongst the most sensitive ecosystems to human pressure and climate change, and are liable to undergo desertification. This is a main concern because this may occur abruptly and irreversibly, with concomitant losses of ecological and economic resources. Such ecosystem shifts have been theoretically attributed to positive feedback and alternative stable ecosystem states. However, verifications and predictive power with respect to such ecosystem dynamics are lacking for spatially extensive ecosystems. Therefore, management and recovery strategies against desertification for arid ecosystems are difficult to achieve. Theoretical models predict that so-called regular vegetation patterns observed in large areas in arid ecosystems world-wide are a result of spatial self-organization, and the shapes of the patterns are associated with approaching desertification thresholds. Also, patch-size distribution of the vegetation in various arid ecosystems follows a power law, and consistent deviations from power laws occur if grazing pressure is high. Model analysis suggests that such deviations from power laws may be a warning signal for the onset of desertification, independent of the vegetation cover. So, spatial patterns of vegetation, not cover, can be used to assess the vulnerability of arid ecosystems to increased human pressure or ongoing climate change. Common ecological mechanisms that account for these patterns are scale-dependent feedback and local facilitation. Our results are relevant to identify areas that are vulnerable to desertification in the face of increased human pressure and ongoing global climate change, as well as for the restoration of areas that are already degraded.