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The engineering of multi-layer patchiness by plants: A framework for comparative studies of the effects of woody vegetation as landscape modulators across drylands

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The concept of ecosystem engineer was proposed in order to understand abiotic environmental modulation by organisms and its effects on the distribution and abundance of biota. This concept was incorporated with patch theory in order to better understand the drivers of biodiversity dynamics. An organism that functions as an ecosystem engineer in the context of patch formation was termed a landscape modulator (LM). A crucial element of the modulation process is the creation of different resource patches having different spatial patterns, resulting in multiple-layer landscape diversity. In this view, the term biodiversity encompasses two components: landscape diversity and species diversity, and the LM concept serves to understand the functional link between these two diversities. Using a multiple-layer landscape diversity model, we synthesized published literature and unpublished empirical data on the effects of woody vegetation on different resource layers (water, soil nutrients, herbaceous seeds and light) along an aridity gradient in Israel. Using large scale field manipulations, we measured the response of herbaceous vegetation to these modulated resources. We found that resources are modulated differently in each location and that the ratio among the modulated resources changes along the rainfall gradient of the drylands. These relationships are the controlling factors for herbaceous vegetation and ecosystem functioning. We offer a conceptual model that uses multiple-layer landscape diversity concept to predict environmental effects of woody vegetation in different parts of drylands. In addition, we explore how anthropogenic and natural disturbances can change woody vegetation's induced environmental effects.