Appendix D. Model description.

In our spatially explicit model, plant individuals are depicted as circles, with a surface area drawn from a normal distribution with a mean of 7 m^2 and standard deviation of 3.5 m^2 (these parameters were determined from the average values measured in the field sites). Starting with an empty plot of 250 × 250 m^2, individual plants were added one by one at random locations until a pre-defined plant cover is reached. Subsequently we remove plants once with a probability (M) that is determined by the harshness of the environment (h_e), and by facilitative ($f(d)$) or competitive ($c(d)$) effects imposed by the adjacent existing plants (for simplicity, we only account for the distance to the nearest neighbor d) as:

$$M = (1 - f(d))\,(c(d) + h_e) \tag{D.1}$$

Meta-analysis and syntheses on the behavior of plant-plant interactions across environmental gradients in drylands have showed a variety of relationships between the frequency or intensity of plant-plant interactions and environmental conditions (Soliveres et al. 2011, Holmgren et al. 2012, Soliveres and Maestre 2014). Therefore, we did not include any change in facilitation strength with the harshness of the environment. We assume that short-range facilitation or long-range competition plays a role, and model their effects using sigmoid Hill functions (Eqs. D.2 and D.3).

$$f(d) = \frac{h^p}{h^p + d^p} \tag{D.2}$$

$$c(d) = \frac{d^p}{h^p + d^p} \tag{D.3}$$

where d is the distance to the nearest neighboring individual, h is the half-saturation constant, and the exponent p determines the slopes of the sigmoids. This 'seedling-mortality' process is repeated until a certain pre-defined vegetation cover is reached. The patch-size distribution is quantified for the generated patterns, and skewness is calculated across the whole range of vegetation cover (0 – 100%). To assess the net effects of facilitation and competition, and to compare them with the null model of complete randomness (CSR), we plotted the skewness of patch-size distribution against vegetation cover for the three scenarios: 1) $f = c = 0$ (CSR); 2) $c = 0$ (net facilitation; $h = 3.0$, $p = 4.0$); and 3) $f = 0$ (net competition; $h = 3.0$, $p = 4.0$). Model analyses were conducted in MATLAB R2011b. We run the simulation of CSR 200 times to calculate the 95% confidence interval. To verify that the results obtained are not an artifact of assuming a pre-defined vegetation cover, we also ran a version of the model where a dynamic equilibrium vegetation cover is reached. Specifically, a number of seedlings were produced at each time step, and their recruitment success was determined as a function of facilitation or competition. Subsequently, there was an extra mortality event for all existing individuals with a probability of h_e. This process was repeated until total cover stabilized to equilibrium, which varied with h_e. The results obtained using this model with dynamically reached equilibrium (Fig. D1) did not differ markedly from those by the simple model, except that under facilitation scenario (blue line in Fig. D1) skewness shows a substantial increase with cover.

The simple model we used in the main text is probably less realistic than its dynamic equilibrium counterpart. However, it can capture the fact that facilitation can lead to vegetation patterns characterized by more right-skewed patch-size distributions in comparison to spatial randomness (the null model). The purpose of the minimal model is merely to show the minimum of additional assumptions needed to describe the higher skewness found in the images. Moreover, our correlation analysis between field observation of plant co-occurrence and remotely-sensed spatial pattern does not depend on which of these models are used. Thus, our results are robust to these two model variants. The simple model is introduced in the main text since it involves a lower number of parameters and assumptions.

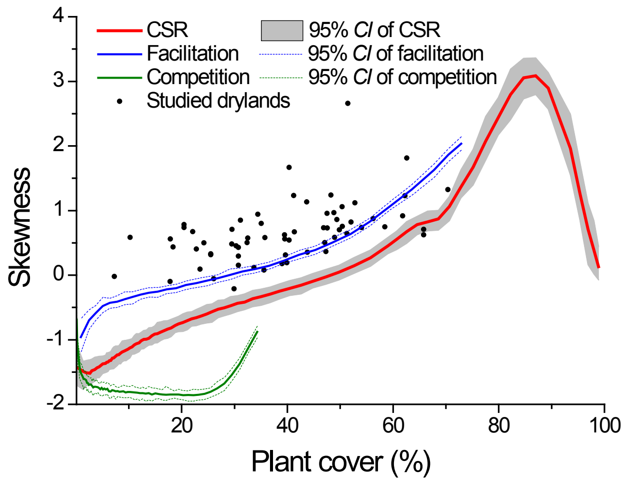

FIG. D1. Relationship between vegetation cover and the Pearson's moment coefficient of skewness of patch-size distribution for the dynamic version of the null model (complete spatial randomness, CSR) and the facilitation model, and the remotely-sensed data for the 65 drylands studied.

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