DRYEX Proposal

WP1. Community-scale field manipulative experiments. A single, large-scale manipulative field experiment will be conducted to achieve objectives O1 to 3. Plant communities with varying levels of plant diversity and patch cover (patch size) will be created *ad hoc* by planting groups (patches) of varying diversity and number of young (3 months old) seedlings on bare-soil plots. The experimental design includes three factors: Richness (S), with three levels (S3. S6, and S9) corresponding with 3, 6 and 9 species respectively; Initial cover (C), with two levels (C5, C15) corresponding to 5, and 15% of initial plant cover (resulting from the establishment of same number of patches of either small or big patch size); and Drought (D), with three levels (D0, D5, and D1) corresponding to control conditions (targeting average annual precipitation), percentile 5 (annual precipitation around percentile 5 of long-term distribution) and percentile 1, respectively. Three replicates (plots) will be established for each combination of treatments. To achieve the targeted Drought levels, water inputs will be manipulated through rainfall exclusion structures and, if needed, irrigation. Nine common dryland species, belonging to four functional groups (perennial grasses; chamephytes, early-successional N-fixing shrubs, and tall late-successional shrubs) will be combined to create increasing levels of species and functional richness. To disentangle the effects of species richness and species composition, different combinations of species will be included within D3 and D6 richness levels.

<u>Task 1.1. Experimental setting</u>: In the framework of a collaboration agreement between the University of Alicante and CEMEX ESPAÑA, S.A (EPO) a bare-soil artificial slope (Fig. 2) has been built and prepared for experimental purposes on a CEMEX property close (2 km) to the University of Alicante campus. On this slope (50 m long x 100 m wide), we will establish a set of 56 (10 x 5 m) plots (four rows of 14 plots each) separated by 2-m wide vertical and horizontal strips that will be kept bare and will serve as border/buffer/operational areas between plots. The resulting combination of S x C x D treatments (3 replicates each) will be randomly applied to 54 of these plots. For any given Diversity level, vegetation will be established on the plots as both monospecific and diverse patches (e.g., a S3 plot including species a, b, and c will include “a”, “b”, “c” and “abc” patches). Patch size will be either 0,25 x 0,25 m (for C5 treatment) or 0,75 x 0,25 m (for C15 treatment). We expect the variation in plant size to be critical for source-sink dynamics and the potential for triggering restoration dynamics. Each plot will be considered as a lattice of 800 cells (0.25 x 0.25 m cell size). Location of plant patches will be selected at random. The two extra plots will be used to grow individuals of each species in isolation (without neighbors).

All plots will be closed at the bottom, using simple and low-cost structures (silt fences; Robichaud and Brown 2002) that allow quantifying net loss of sediments from the plots (proxy for runoff and nutrient losses) and disconnect overland flows between plots.

All plots will be equipped with simple supporting structures for the installation of rainfall exclusion systems. Conversely to most common rainfall exclusion experiments, which aim to reduce a certain amount of water input from each rainfall event, our experiment aims at enlarging the summer drought period, to better reproduce projections of climate change models on the (increasing) frequency of extreme events. Thus, we aim at fully excluding some of the pre- and post-summer rainfall events (spring and autumn rainfalls). Each year, the rainfall exclusion systems (based on series of gutters; see C1.5) will be installed and uninstalled as needed to achieve the target drought levels describe above.

Figure 2. Artificial slope prepared for Task 1.2 to 1.4 experiments as part of a collaboration agreement between the University of Alicante and CEMEX ESPAÑA S.A (Interested entity). Drawing outline plot distribution and the variety of diversity levels and types of spatial patterns (big vs small patch size) that will be used as control factors.

Task 1.2. Testing the effect of plant diversity and cover on triggering recovery trajectories as a function of drought pressure (O1): For each combination of diversity x cover x drought treatments, we will assess plant cover dynamics at the plot scale. Periodic (seasonal) high resolution photographs will be taken from a UAV (equipped quadricopter) and vegetation maps will be derived from these images and processed to estimate changes in plant cover and pattern and associated changes in hydrological connectivity (using Flowlength methodology; Mayor et al. 2008). Ground-based monitoring of plant cover dynamics of individual species (along permanent cover transects) will complement aerial photography and inform about species composition and relative abundance changes. Monitoring of sediment yield at the bottom of the plots (captured by silt fences) will provide information on overall resource losses. From these data, we will assess how plant functional and species diversity influence the dynamic response of dryland communities to increasing drought levels and identify the minimum diversity x cover level that triggers a successful colonization dynamics under various water-stress conditions.

Task 1.3. Testing the role of plant diversity promoting soil biodiversity and enhancing soil functioning (O2): For the same combination of treatments than above, we will monitor functional diversity of soil fauna (focusing on microarthropods) and of the microbial community (based on carbon substrate utilization; see MicroResp™), and will assess nutrient availability (PMN, available P, SOC), nutrient cycling potential (enzyme activities), and soil moisture dynamics (continuous-monitoring soil moisture probes) at the plot scale (stratified sampling for the various types of patches and for bare soil). Baseline initial conditions for all the soil variables above mentioned will be established from a first assessment conducted before the establishment of the plant communities. Soil monitoring will concentrate on the last 2/3 of project duration, as it can be expected that plant-diversity influence on soils will be minor during the earliest stages of plant establishment.

Task 1.4. Testing the effect of water stress on community-scale plant-plant interactions as a function of species richness (O3). For each plot (replicates of the combination of diversity x cover x drought treatments), we will compare species performance (survival, growth, reproductive effort) at the patch scale between diverse and mono-specific patches as well as with individuals of each species growing in isolation (see Task 1.1) and estimate intensity and importance (*sensu* Welden and Slauson 1986) indices (Armas et al. 2004, Seifan et al. 2010, Mingo 2014) of plant-plant interactions along

gradients of stress and diversity. The results from this task will inform about how the outcomes of plant-plant interactions are modulated by the complexity of the community and the environmental stress (water scarcity) and will provide insights on the mechanisms behind the role of diversity in dryland dynamics. An expected output from this task is the development of a conceptual model that represents the outcome of plant-plant interactions along gradients of diversity and environmental stress. In addition, the results from this task will help to establish a ranking of specific competition strength for a variety of conditions and species combinations.