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Tall trees safeguard biodiversity under climatic changes: assessing the effect of tree size, soil moisture, and vegetation density on tree survival

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Soil water availability is a major limiting factor to drylands' vegetation worldwide. Soil water is among other factors related to precipitation and both factors in turn drive both animal and plant diversity. In arid lands, trees in particular are keystone species for other plants as well as animals providing shelter. In addition, trees in arid locations protect the soil through their rooting system, deterring land degradation and maintain soil and soil moisture. Climatic changes are impacting arid areas and this effect is predicted to become more pronounced in the near future. Therefore, survival of trees in arid areas is crucial for ecosystem functioning as their death is likely to introduce cascade effects on other species as well as in soil surface water availability. Arid lands are poorly studied ecosystems as they often lay far from developed areas and the human population density is low; however, this makes them ideal study areas for climatic changes and eco-hydrological functioning. A large spatio-temporal dataset containing data on soil water availability, precipitation, and a very large number of tree individuals followed one-by-one over a period of 30 years was derived in the Kalahari, Africa, a place where water is scarce. Here we show with these data, that during the past 30 years rainfall has been both reduced in magnitude but increased in variability. Monitoring long-term tree survival indicated that while rainfall was uniformly distributed across the study areas, soil water was higher in the vicinity to tall tree individuals. This result became more pronounced as rainfall decreased. Tree survival was also higher closer to tall tree individuals and this result became more pronounced as both rainfall and soil water availability on bare ground (i.e. away from tree canopies) decreased. These result indicate that tall tree individuals are keystone species for plant survival safeguarding biodiversity in arid lands. Maintaining or establishing tall tree species in such areas facilitates other vegetation under water stress.

Keywords: biodiversity, climatic changes, soil moisture