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Long-term effects of water harvesting systems on soil and vegetation dynamics in a semiarid region, Israel

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Desertification processes affect ground surface properties and soil-water availability, thus impacting vegetation dynamics and ecosystem functioning. Semiarid areas – encompassing the major part of grazing lands and providing a wide range of ecosystem services – are subjected to both 'natural' and anthropogenic degradation processes. Afforestation has been widely accepted as an effective means of halting land degradation and adapting to climate change. However, recent studies have shown that dryland afforestation might adversely affect geo-ecosystem functioning.

Across the Israeli drylands, afforestation projects have been implemented by the Keren Kayemet Le'Israel (KKL) to restore degraded lands. These projects rely on harvesting water overland flow and are designed to accumulate runon water, sediments, and nutrients from runoff contributing source areas. Such systems have been established both in hillslopes and valleys, allowing the support of woody vegetation, such as trees and shrubs. The most common runoff harvesting systems in the northern Negev region are contour bench terraces (in hillslopes) and limans (in valleys). In the hillslope-afforestation systems, the woody canopy coverage area varies from 0.1% in the youngest planting areas to ~1.0% in the eldest areas.

In this study, we analyzed the temporal development of different planted sites in the Ambassador's afforestation land. The area has been under afforestation since 2005. For this study, we selected four sites within the afforestation area, including (1) undisturbed, control hillslopes, where no water harvesting systems nor tree planting have been conducted; (2) hillslopes that were planted just before the hydrological year of 2005; (3) hillslopes that were planted just before the hydrological year of 2009; and (4) hillslope that were planted just before the hydrological year of 2016.

Long-term analysis of meteorological trends revealed that the area had been subjected to substantial climatic change. A decadal rate increase of 0.45°C was observed in air temperature, while a 1.3% decrease in (minimal) relative humidity. Although a long-term change in evapotranspiration has not been detected, summer values have been significantly increased.

For each of the afforestation sites (2005, 2009, and 2016), a significant reduction in seasonal Normalized Difference Vegetation Index (NDVI) values were recorded compared to the undisturbed slopes, a trend that took place until the establishment of runoff harvesting systems. However, in the 2005 and 2009 sites, the NDVI seasonal average was significantly higher after the establishment of runoff harvesting systems than that in the prior seasonal values, as well higher than that in the undisturbed hillslopes. At the same time, in the newly disturbed sites planted in 2016, the average seasonal values were substantially lower after the establishment of runoff harvesting systems than those in the prior year.