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Modeling the radiation balance within a planted trench system

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Micro-catchment systems (MCs) are designed to harvest and utilize rainwater, with the aim of supporting tree growth in arid regions. While MCs were traditionally built with shallow infiltration basins, recent research indicates that MCs with deeper basins retain more water than MCs with shallower basins, and that trees grown in deeper MCs outperform those grown in shallow MCs. This may be partially because the flux of incoming shortwave radiation reaching the surface is decreased in deeper basins. The degree to which the incoming radiation reaching the floor of the MC is reduced, however, depends on the system's dimensions and orientation, geographical location, canopy geometry, soil properties, date, and time.

Existing radiation models are either capable of modeling radiation penetration into trenches, or describe transmission of radiation through canopy. None can describe the penetration of radiation through canopy into a trench. The goal of our research was to model the incoming shortwave and longwave radiation flux densities reaching a MC floor in which trees are planted. The model calculates the incoming shortwave and longwave radiation at any given point on the trench floor. In calculating the incoming shortwave radiation, the model considers direct radiation, diffuse radiation, and direct and diffuse radiation reflected from the walls of the MC system. The model also accounts for possible shading and attenuation of the radiation caused by the presence of a canopy in the system.

Validation of the model is performed by comparing measured incoming shortwave radiation to modeled outputs. The measurements are conducted at various positions within existing trenches with width of 1 m and length of 12 m, in which three 6-year old olive trees are grown, with 4 m spacing between trees. The flexibility of the model and the ability to change the trench configurations will help enable the maximization of water use efficiency inside MC systems.