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Optimization of contour ridge water harvesting systems for arid zones.

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Runoff is generated along slopes in semi-arid regions during rainfall events and flows into the lower lying areas, usually ephemeral streams. Depending on the slope and volume of water involved, the flow can become turbulent and cause the detachments of soil particles (erosion). The purpose of the system under investigation is to capture the water after a relatively short flow distance and allow it to be absorbed by the soil. This action accomplishes two objectives: erosion is averted and the stored water can be used for plant production. Depending on the ratio of contributing to receiving areas and storm characteristics the stored water can be significantly higher than the precipitation.

The objective of the present project was to develop a simple model that describes the above biomass production in such a system and allows to determine the optimum distribution of structures along a given slope in order to meet one criteria (e.g. minimize variance, maximize production, maximize lowest production, etc.) or a suite of them.
The basic assumption is that tree above ground biomass production is linearly related to transpired water, the latter driven by an external force (potential evaporation) and modulated by water availability in the soil. PET is computed using the standard Penman-Monteith formulation for evaporation from open water bodies, if the latter is not available. Four water fluxes are computed: Evaporation, Transpiration, Runoff and Drainage, the first two not interacting directly. All of the above mentioned fluxes and rates are daily lumped values and water content in the profile is updated daily, assuming that rainfall events happen after the computation of fluxes.
Daily water inputs are estimated from rainfall data and computed runoff. A dynamic runoff coefficient (=cumulative generated runoff generated/cumulative precipitation) was derived from measurements carried out in the area and used in order to estimate runoff volumes from total recorded precipitation and varying runoff generating areas.
Tree development, as parameterized by cross-sectional canopy area, was estimated from the sigmoid that describes cross-sectional as a function of cumulative water used.
Results of simulations carried out for consecutive five year periods in one thirty-year period indicated that contour ridges at 2 m. intervals resulted in the highest canopy covered area, irrespective of soil depth.