Modeling-based performance assessment of an indigenous macro-catchment water harvesting technique (Marab) in the Jordanian Badia

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Abstract

Water resources management is fundamental for rural communities in drylands. Water Harvesting Technologies (WHT) intercept and store the excess rainfall (surface runoff) in soils for increased plant available water and agricultural productivity. The so-called 'Marab' WHT was initially developed by Middle Eastern agro-pastoralists that reside or commute in semi-arid and arid rangelands. The Marab WHT is a macro-catchment measure consisting of earth dams and stone spillways along the contours of a lowland depression or floodplain. Dependent on the local context (i.e. climate, soil, management, etc.) the established Marabs show highly-variable effectiveness. This study aims at filling the knowledge gap on the WHT's performance in changing environments by simulating its hydro-agrological effects for different soils and climatic conditions using the AquaCrop model. A case study performed for a Jordanian Marab over three seasons (2019-2022) confirms its huge improvement potential for barley production. Through Marab-farming, barley production reached 8.37 t ha $^{-1}$ on average, versus highly variable 0.34 t ha $^{-1}$ without the WHT. The simulation-based assessment of soil textures identified that silty soils have the largest potential for producing up to 9.25 t ha $^{-1}$ barley, compared to 6.60 t ha $^{-1}$ produced in clay soils. Assessing different climate scenarios, a slight increase in daily average temperatures (+ 0.5°C) led to a considerable production decline of 4-8%, while a significant reduction of precipitation (-20%) decreased biomass production by a similar rate (4-10%). This underlines the robustness of the 'Marab' WHT to rainfall amount variation. However, simulations also highlight the sensitivity of timing and frequency of flood events: removing the last and the first flood event reduced biomass production by approximately 50% and 80% respectively, while the barley fails to develop if both events were suppressed.

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