Modelling a small-scale rainwater harvesting system for irrigation using SWAT

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Abstract

In many regions, the water available for allocation to irrigation has reached its limit and that there is a need to identify alternative sources. Large scale irrigation schemes are available for farmers to buy in in certain part of the country. However, not all farmers will have access to water from large scale irrigation schemes and this has led some hill country farmers to consider the potential to construct their own, relatively small, dams on their properties to capture and store water for irrigation. The major challenge to estimating the potential benefits of water storage for irrigation is reliably simulating the likely volume of water that can be captured.

This thesis models the rainwater harvesting potential of a hill country farm in the Wairarapa region (Riverside Farm). Soil Water Assessment Tool (SWAT) has been selected to model the water harvesting potential due its ability to separate runoff, lateral flow, and the ground water contribution to the harvestable water according to the local topographic, soil and land use properties. This allows the modeller to consider a wide range of scenarios.

A SWAT model was set up for the water harvesting catchment (WHC) on the case study farm. The WHC is ungauged, however it is nested within a larger catchment called the Calibration and Validation Catchment (CVC). CVC is gauged and therefore flow data can be obtained. Improved parameters obtained through CVC calibration is transferred to the WHC, this process of donating calibrated parameters to a hydrologically similar ungauged catchment is called parameter regionalization.

The model suggests that the storage scheme can meet the average irrigation demand of 43 ha of land 90% of the time. The predicted water harvesting potential decreases with regionalized parameters when compared to the default settings which suggests that there is a risk that some modelling may overestimate the volume of water that can be captured.

The economic impact of irrigation was also assessed in this study. The cost of one extra kilogram of pasture dry matter production is estimated to be between 39-44 cents/kg. Nitrogen fertilizer application can increase pasture yield but it is not a perfect substitution to irrigation because nitrogen fertilizer is not to be applied during drought. However, purchasing supplement feed from outside the farm might be a cheaper alternative to building a small-scale dam.

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