



**Example of MSc thesis related to the Soil-water  
interaction Research Line of the Wageningen University  
Soil Science cluster**

**Modelling the impact of Farmer Managed Natural  
Regeneration agroforestry technique on water balance and  
runoff control with SWAT model**

**A case study from the Dodoma Region, Tanzania**



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### Abstract

Land-use changes and climate variability are two of the main causes of watershed hydrology changes. Deforestation and land degradation led to an increment of soil erosion and flood occurrence in the Dodoma Region, one of the poorest regions in Tanzania, where most of the income comes from rain-fed subsistence agriculture. As a possible solution to these threats, JustdiggIt, in partnership with the LEAD Foundation and MetaMeta, implemented the Dodoma Region (Tanzania) the Farmer Managed Natural Regeneration (FMNR) technique, an agroforestry practice consisting of the regeneration of leaving stumps in agricultural areas. Since the impact of this practice on the water balance and runoff control in the Region was unknown, a land unit map was produced to select two basins representative of the whole Region (Basin 19 and 23). A literature review was then conducted to decide which model to use to investigate these impacts. Eventually, the Soil and Water Assessment Tool (SWAT) model was selected as suitable for this research. The SWAT model was finally used to investigate four scenarios, simulating different percentages of trees coverage. The first scenario represented the actual trees coverage simulating young trees (1%), the second one the actual tree coverage simulating adult trees (1%), the third one the target adult tree coverage (2%) and the fourth one a possible future tree coverage (5%).

The model was manually calibrated and validated on Basin 19 for a period of respectively 9 and 2 years, using actual evapotranspiration (AET) data from the MODIS16 (MODerate Resolution Imaging Spectroradiometer 16) database. The model performance was assessed by the coefficient of determination ( $R^2$ ) and Nash- Sutcliffe Coefficient of Efficiency (NSE), scoring for the calibration period  $R^2=0.86$ ,  $NSE=0.68$  and for the validation  $R^2=0.9$  and  $NSE=0.83$ . A second validation was performed on Basin 23, resulting in the following values:  $R^2=0.84$ ,  $NSE=0.5$ . The model outcomes indicated that the FMNR practice decreases surface runoff up to 2% while the groundwater recharge was simulated to increase by almost 7%. Moreover, a decrement of soil water content (-0.3%) and increment of 0.1 % in the evapotranspiration (ET) was simulated. Overall, the research results indicate that an increment of tree coverage has more impact on groundwater recharge compared to surface runoff. Nevertheless, more research has to be conducted to improve the input data implemented in the model and the influence of the calibration method used.

**Keywords:** agroforestry, SWAT model, Dodoma Region, water balance, runoff control