Evaluation of soil and water conservation measures in a semi-arid river basin in Tunisia using SWAT

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Abstract

The Merguellil catchment (central Tunisia) is a typical Mediterranean semi-arid basin, which suffers from regular water shortage aggravated by current droughts. Over recent decades, the continuous construction of small and large dams and soil and water conservation works (i.e. contour ridges) have taken place within this watershed. However, little is known about the effect of these water-harvesting systems on the water balance components of arid or semi-arid basins. In this paper, we present the results of a study, which evaluates the impact of the contour ridges on water balance components and erosion at basin scale by using the soil and water assessment tool model (SWAT). Large dams were modelled as reservoirs, small dams as ponds and contour ridges as potholes that fill with water and increase the percolation into the aquifer. The model predicts that contour ridges produce annually a reduction of 32 and 21% in surface run-off and river discharge, respectively, and an increase in aquifer recharge of 50%. At the same time, retention of a large proportion of entrained sediment (26%) was modelled.

Keywords: Soil and water conservation works, SWAT model, semi-arid region, catchment management, hydrological changes

Introduction

Arid and semi-arid regions, such as North Africa, experience acute water shortage due to population growth and economic development. Water resource management is critical as it impacts the livelihood of the people and agricultural productivity. For thousands of years, the inhabitants of these dry areas have constructed water-harvesting systems to cope with limited water supply (Boers, 1994; Oweis \textit{et al.}, 2004). Impoundments were built to capture surface run-off from sparsely covered, rocky mountain slopes. These structures are known to reduce soil erosion, but despite their long and successful history, little is known about their hydrological impacts.

For thirty years, the Tunisian government has put considerable resources into soil and water conservation works (SWCWs) through institutional and legislative measures. The Ministry of Agriculture enacted a national strategy for soil and water conservation and agricultural development for 1990s by managing slope stability and surface water management. A number of hill dams (1000) and structures for flood control and groundwater recharge (4000) were constructed and ca. 600 000 hectares received conservation measures. These actions were coupled with regional resource planning involving a number of governorates. Generally, soil and water conservation works (SWCWs) are built in the uplands to mitigate erosion and water scarcity problems. These structures capture run-off from contributing hill slopes, thereby allowing captured surface run-off to infiltrate and replenish local groundwater. The rapid expansion of SWCWs has raised questions concerning their hydrological impacts on water resources at basin scale, especially where conflicts exist between upstream and downstream water users (Le Goulven \textit{et al.}, 2009).

Water-harvesting systems intercept run-off, thus depriving downstream users of shared water resources (Oweis \textit{et al.}, 2004).