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Hydrology and Earth System Sciences Discussions

Interactive comment on "Modelling water-harvesting systems in the arid south of Tunisia using SWAT" *by* M. Ouessar et al.

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Interactive comment on “Modelling water-harvesting systems in the arid south of Tunisia using SWAT” by M. Ouessar et al.

Anonymous Referee #1

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This paper by Ouessar et al describes the application of the Soil Water Assessment

Tool (SWAT) to the arid watershed of wadi Koutine in south east Tunisia. The SWAT model was modified to simulate the operation of two traditional water harvesting structures, and to allow the model to adequately represent Mediterranean arid cropping systems. The model achieved reasonable model performance criteria given the normal data issues in such regions. There are few published studies of the application of SWAT in truly arid climates, making this a potentially useful contribution to the literature. However, this present paper fails to provide this contribution. It’s critical weaknesses are:

1) There is insufficient description of the model changes made to SWAT-WH. Given that this represents one of the main potential contributions of the paper, this is a significant limitation of the current manuscript.

(a) In Figure 3, there appear to be no losses or outflows from the water harvesting structure assumed to be represented by the dashed box that receives runoff from the HRUs, This suggests that there is no bed percolation / transmission losses, evaporation and that the water harvesting exactly matches the runoff from the multiple HRUs. Surely this is not the case, and this figure should be clarified

AC.

We agree that Figure 3 is not fully clear and we have improved it by moving the dashed box to the corner of the subbasin frame and connecting it with the streamflow and transmission losses arrows. As explained in section 2.3, the amount of water harvested (runoff) by the HRUs is controlled by two factors: the flow fraction (FLOWFR) (set to 0.90 for jessour and 0.95 m for tabias) and the equivalent height of the spillway (DIVMAX) (set to 0.25 m for jessour and 0.15 m for tabias). Therefore, any excess will flow downstream and could be subject to transmission losses in the main reach (wadi). The percolation and evapotranspiration processes of the water-harvesting HRUs themselves are displayed in the WH-HRU box. It is assumed that all harvested water infiltrates directly in the soil, so no open water evaporation losses are accounted for. This

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assumption seems reasonable, considering generally only few days pounding (max 2 to 3) during humid conditions with relatively low temperature and good cloud cover.

(b) I would recommend that Figure 4 is re-drawn to better represent the implementation of the traditional water harvesting structures within the context of SWATs representation of sub-basins

AC.

The figure 4 will be redrawn as recommended.

2) The results are very well described, but the discussion of the results is lacking- there is no justification that the model is producing correct results for the correct reasons. For example:

(a) In describing the simulated recharge, it is said that the recharge is too high but the reasons for this are not discussed. Might it be due to a different interpretation of the aquifers (between SWAT and the conceptual model of the system); that the simulation of actual evapotranspiration was wrong; or that the assumed soil profile was too thin, thereby limiting soil water availability etc?

AC.

The recharge rates computed by SWAT were higher than found by the groundwater model of Derouiche (1997). A potential reason is that in SWAT all water leaving the soil profile (percolation) is assumed to reach the aquifer as recharge, while in reality a portion could be retained in the vadoze layer. Obviously, groundwater recharge in SWAT is sensitive to the soil depths and AWC (see also Table 4). However, the recharge results from Derouiche (1997) may also not be correct, because in her groundwater modeling application she computed the recharge from a limited number of groundwater level observations, while assuming that all boundary conditions (inflow from other aquifers and outflow to the sebkha) were constant.

(b) The discussion of the results focuses on runoff events, but does not demonstrate

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that the model is functioning correctly. During the occasional extreme rainfall events, the size of the runoff event might overwhelm the detail of the hydrological response of the catchment, so that the model is almost guaranteed to provide a response. I would expect to see discussion of the other elements of the model; Are the yields reasonable? is the irrigation volume appropriate? are the size of the transmission losses with the wadis consistent with Derouiche (1997) or other studies in the arid region etc etc.?

AC. Crop water use, growth and yields seemed realistic but need further data collection and calibration as recommended in the conclusion.

A comparison with other similar arid watersheds was made in section 3.3, p.1884-L13-17, but obviously recharge is very variable from one site to another. In addition, the specificity of our site is that it is heavily terraced by water harvesting structures which affect the water flows in the watershed. For comparison with Derouiche (1997), please confer to AC 2(a) (above).

(c) The implications of using different raingauage allocation of the first 3 years pf the 12 year evaluation period is not discussed, Might this have contributed to the lower model performance during the evaluation period?

AC.

Certainly the raingauge allocation has a major effect on the model results. However, we tried to use as maximum data available as possible.

3) The water balance equation given for the "watershed" is incorrect as it does not represent the full water balance of the system. It may be that it is trying to represent the water balance of the landscape surface (soils and steams)

AC. Agreed. We have changed this in section 2.2 as follows: …. the water balance of the soils and streams of the watershed can be expressed as follows P=Qsurf + ET + Wseep + Qgw where, P is the precipitation, Qsurf is the surface runoff out of the watershed, ET is the evapotranspiration, Wseep is the percolation from the soil profile,

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and Qgw are the transmission losses from the streams. All parameters are expressed in (mm) over the watershed area.

For our case: P= Precipitation ET= Evapotranspiration Qsurf= harvested water + runoff and lateral flow Wseep= Percolation from the soil profile. Qgw= Transmission losses.

In Table 5, we put only the ET and percolation from different land uses. So, the transmission losses from the streams are not included there.

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