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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.

Anonymous Referee #2

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General comments

The objective of this paper is to adapt and evaluate the well-known distributed model SWAT for simulating the hydrologic processes in arid Mediterranean environments taking into account water-harvesting systems. The methodology consists on developing a methodology to represent water harvesting in SWAT and to adjust the crop parameters to the specificities of Mediterranean arid zone. The wadi Koutine watershed (270 km^2) Southern Tunisia was selected as a study case.

The objective of the paper is of international interest for modeling the impact of man-made management such as embankments and dikes, called jessours and tabias in Tunisia, constructed for water harvesting in arid zones. The bibliography is complete

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and of international broad. In the literature, very few models enable to take into account jessours and tabias, and the development of a model which takes into account hydrological processes through these two structures is fully justified. The paper is well structured and well written, and the study case well adapted to the objectives. The modified version of SWAT (called SWAT-WH) was applied in order to calculate at the whole watershed scale, the water budget at the flood event scale and for a set of 38 flood events (from 1973 to 1985). However, the paper did not present a clear analysis of the main hydrological processes through jessours and tabias, lacks of hydrologic analysis of the hydrological, meteorlogical and cartographic data on the study site, and lacks of soundness in discussion. My major comments concern:

1. The hydrologic processes through jessours and tabias: The study of hydrologic processes through jessours and tabias is one of the main originality of this paper. However, it is not clear from the presentation of jessours (page 1868, lines 22-29) and tabias (page 1869, lines 1-7) what are the similarities (from hydrologic point of view) and what are the differences between these two structures. Figure 2 is not clear enough to present the main differences: for example in the scheme of the Jessr component (b), there is a tabia! A clear scheme should be added to compare jessours and tabias, showing for each structure the hydrologic processes, the main geometric parameters, and how to represent the hydrologic processes in the model. If I understand well, both jessours and tabias are represented in SWAT-WH using the same approach; if this is the case, why to distinguish two types (jessours and tabias)? SWAT-WH and SWAT should be applied and compared at the scale of one Hydrologic Response Unit (HRU) corresponding to a jessour or a tabia, in order to show the shortcomings of SWAT, the improvements obtained using SWAT-WH and the main hydrological processes at the local scale.

2. The hydrologic processes on the study site: The paper lacks of a hydrologic analysis of flood events. Few hydrologic characteristics, such as total rainfall, runoff, and rainfall intensity, are given at the end of the paper (for example page 1882, lines 1-17 and

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27-30; page 1883, lines 1-9). First, the paper must be strengthen by presenting a complete analysis of the available data (rainfall, runoff, potential evapo-transpiration) by presenting an estimation of the annual water budget using the measured data. A similar analysis must be conducted at the event scale by presenting the characteristics of rainfall events such as duration, total rainfall, total runoff, peak flow, etc. (present for example the classical graphics showing the relationships between these characteristics for calibration and validation events). Are there any missing data? What is the accuracy of data? What are the terms of the observed water budget? Second, the paper must analyze the geographic characteristics of the watershed, especially the exact location on a map and the dimension of jessours and tabias. A discussion must analyze the geometric characteristics of these structures, in order to justify the adequate range of parameters.

3. Justification of the choice of the model: The justification of the model to be used is not clear in the introduction. The authors say that few of the available watershed models can be easily applied to simulate the high spatio-temporal variability processes in arid watersheds (page 1866, lines 2-4). This assumption is not true, because a large number of models are adapted to the arid region, probably not to take into account the role of jessours and tabias. However, the authors justify the choice of SWAT (page 1866, lines 4-9), not because it is well adapted to arid regions, but for technical reasons. The authors should first justify the constraints of modeling jessours and tabias (see above in 1), and then choose a model well adapted to take into account these structures. When reading the conclusion of the paper, one may ask if a global model is not adapted to calculate the terms of the water budget. Why do we need a distributed model? Justify also the adequacy of the daily time step (fixed in SWAT) for simulating hydrological processes during short-duration high-intensity events?

4. The parameterization strategy: The paramaterisation strategy is well conducted in order to give a range of variation for the main model parameters as shown in section 2.4. However, the section 2.4 lacks of a synthetic conclusion showing a list of the whole

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parameters of the model, the parameters to be fixed, and the parameters to be calibrated. The paper should present maps showing the spatial variability of Hydrologic Response Units (HRU), jessours and tabias location, soil, and land use. Particularly, the two parameters DIVMAX and FLOWFR need to be addressed specifically because they represent the specific role jessours and tabias. How to spatialize these two parameters, and can they be considered identical for all jessours and tabias? A second point concerns the comparison between SWAT and SWAT-WH at the catchment scale. The paper does not demonstrate that SWAT-WH gives better results than SWAT because no comparison was established. A comparison between SWAT-WH and SWAT at both the local and catchment scales enables to demonstrate the advantages (or not) when introducing jessours and tabias. I think it is one of the main points to be addressed in a revised version because it enables to better understand the hydrological processes through jessours and tabias, and enable to discuss the domains and limits of applications of SWAT-WH.

Specific comments:

. Page 1866, lines 2-4: Please explain why we cannot use the available models?

. The introduction must introduce the water-harvesting systems (jessours and tabias) and the difficulties to represent them in hydrological models.

. Page 1867, line 15: indicate what hydrological processes will be modified by the water-harvesting system.

. Page 1867, lines 21-25: Indicate on a map the location of Jeffara, Médenine, Matmata, Sebkha Oum Zessar, Hallouf, etc.

. Page 1869, line 25: Please explain WXGEN.

. Page 1870, line 2: Please give a list of the available data on the study site which justify the choice of the Hargreaves method.

. Page 1872, line 25: Please give a map showing the 35 sub-basins or HRU.

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. Page 1873, lines 12-18: Please check the name of all locations which differ between the text and the map on figure 1: Allamet and Alamat, Toujène Dkhilet and Toujène Edkhila, Ksar and Kasr, Béni Khédache and Béni Kedhache, etc.

. Page 1874, line 7: Is it TABS or STAB?

. Page 1874, line 20: Please comment Table 1.

. Page 1875, line 5: Please explain to what corresponds the group D?

. Page 1876, lines 10-16: The new parameters DIVMAX and FLOWFR added in the application worth a detailed discussion function of observations on the study site.

. Page 1877, lines 6-25: Please explain how was established the reference scenario. Is there any calibration function of measured data?

. Page 1879, line 1879: What is the value of n?

. Page 1880, lines 15-25: Please explain the significance of the relative sensitivity RSI values.

. Page 1882, lines 2-3: Data analysis shows that 50% of the total runoff is produced by only two events from 38. Consequently, the calibration procedure, the Nash-Sutcliffe criteria and the R2 are closely related to the calibration of these two events. A discussion needs to be undertaken, to analyze what is the impact of these two events in model calibration, and in the total global budget.

. Page 1893, Table 2: Please explain HYDGRP.

. Page 1895, Table 3: Please justify why the same interval variation is not used for all parameters (for some parameters the variation is 5%, 10%, 20%, and 50%). Why similar intervals are not used? For all parameters, the minimum and maximum scenarios correspond to +/- the same value, except for CN (+5% and -10%). Please explain. In Table 3, please give also the absolute value of the parameters DIVMAX, FLOWFR, Ksoil, AWC and Cn as for Kchan.

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. Page 1898, Figure 1: Please indicate the location of sites on the map of Tunisia.

. Page 1899, Figure 2: The Figure is not clear and does not enable to compare jessours and tabias. Also, the character size is small.

. Page 19052, Figure 5: The y-axis of runoff does not enable to compare measured and calculated values. Please enlarge the scale of the axis, and enlarge the size of characters.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 1863, 2008.