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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "Assessment of alternative land management practices using hydrological simulation and a decision support tool: Arborea agricultural region, Sardinia" *by* P. Cau and C. Paniconi

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1. "There is no clear distinction between the presentation of the Methodology, Results, and a Discussion of these results." "The results of analysis done are not explicitly presented". "In Section 2, 'Description of the hydrological model and the decision support system', the authors are describing the model used which is part of Methodology." "In Section 3, 'Model setup and simulation', the authors are describing how they set up the model on their study area. This section also covers how data was obtained for Soil and Land Cover, derivation of daily rainfall from monthly data, how model calibration was done, and finally how they did simulate streamflows, nitrogen, and phosphorous. Thus

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this section is mainly part of Methodology as it cover HOW the study was undertaken. The results of model calibration are mentioned just in passing."

We have reorganized the paper, changing section and subsection titles and content to more clearly reflect a "methodology - results/discussion" structure. In particular, Section 2 is now called "Methodology" and contains subsections that describe the hydrological model (2.1), the DSS (2.2), and the model setup and calibration (2.3). This latter subsection is new, taking material from what was a standalone section in the previous version of the manuscript but more properly belongs in a "Methodology" section. Subsection 2.3 is subdivided into subsubsections describing the land surface data (2.3.1), the climate data (2.3.2), the definition of the scenarios for the DSS context (2.3.3), and the calibration of the model (2.3.4). The "Scenarios" subsubsection is new, taking the first 3 paragraphs of text that in the previous version was in subsection 3.4 (Simulation results), and adding a new paragraph as well. The "Calibration" subsubsection (which used to be in the same section as "Simulation results") is significantly expanded (more on this below). Compared to the previous manuscript, "Simulation results" (formerly subsection 3.4) and "DSS application" (formerly section 4) have now been brought together as two subsections (3.1, "Hydrological model simulations" and 3.2, "DSS application") under Section 3, now called "Results". Subsection 3.1 is now focused solely on presenting the model and analysis results, having moved the more descriptive material defining the scenarios into subsubsection 2.3.3.

2. "Section 4 'DSS application' [now subsection 3.2], this mainly presents HOW the decision support system part of the modeling was used. Three out of four paragraphs are addressing HOW the decision support system was used in the study. The last or fourth paragraph presents the results of the use of this model."

After describing, in subsection 2.2 (now part of the "Methodology" section), decision support systems in a more general context, the specific features of the MULINO DSS, the Arborea land use options identified for analysis in this paper, and the links between the hydrological modeling and the DSS components of our study, in subsection 3.2

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(now part of the “Results” section) we describe the specifics of the DSS application (parameter values assigned, analysis options used, etc) and the resulting outcome.

3. “Section 5 ’Conclusions’ [now section 4], this presents the conclusions of the study.”

Yes.

4. “There is no clear distinction between a description of the methods, results, and discussions.”

See point 1 above.

5. “Results tend to be presented to illustrate how a particular method was used.”

The results of our model simulations are used to provide input to the DSS, and the overall analysis is used to assess land management alternatives for a real application. This is consistent with the intent of our paper as described in the Abstract and Introduction. Indeed we would like to stress this conjunctive model/DSS aspect of our paper, which we feel is one of the main contributions of the work. As mentioned earlier, the comments from both reviewers are focused mainly on the structure of the paper, the data used, and the hydrological simulations. But equally important is how these simulation results can fit into a decision analysis framework supported by a recently-developed DSS, as demonstrated in the paper. Thus the simulations are not an end in themselves, and for this reason may not be as exhaustive as the reviewers would like to see; an explanation and application of the multicriteria DSS (a novel tool in this context), using information from simulations and other sources, is the final objective. This point is reiterated at the end of our Conclusions (in both the original and revised manuscripts).

6. “The authors have not addressed how the use of data available at different spatial and temporal scales affected the accuracy of their streamflow simulation. For example, soil properties were derived from a 1:250 000 soil map while land cover was obtained from a 1:100 000 map, how did they deal with this problem of using data obtained at

different spatial scales?”

We agree that the spatio-temporal scale of data from different sources is an important and complex issue, indeed one that has been investigated in numerous studies. To examine the impact of data resolution on our simulations would require that source data (e.g., a soil map) be available at different measurement resolutions, something which was not available for our study. Given that this is just one contributor of many to simulation accuracy and uncertainty, and that in our study the simulations were not an end in themselves, we simply ensured that our data was consistent and compatible with SWAT and the HRU/subbasin scales of interest. We did, however, revise the paper to include a better assessment of the impact of rainfall data, perhaps a more important factor than differences between soil and land cover resolution, in response to the reviewer’s comments (next point).

7. “The authors state that they had problems in obtaining daily precipitation data, and generated synthetic precipitation daily time series. How did the generated daily time series compare with the measured precipitation at perhaps a few stations with daily data? How well did the synthetic daily time series preserve properties such as duration of dry and wet spells, daily rainfall amount. Precipitation is the major driver for hydrological processes and outputs of SWAT greatly depend on how accurate the precipitation data is. The authors do not however inform the readers whether synthetic daily time series used represented accurately conditions within the selected basins.”

At the end of subsubsection 2.3.2, “Climate characterization” (formerly subsection 3.2), we have added the following text (and a new table, now Table 1):

“In this way, the data series for the 20 rainfall gages closest to the two basins under study (Fig. 3) were downscaled to daily data series. The AVSWAT GIS interface reads the location of the climatic and rainfall gages and automatically associates to each HRU the nearest corresponding data time series. Table 1 reports the PW/W and PD/W values for the study area.

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Precipitation is the main driver of hydrological processes, and SWAT outputs greatly depend on how accurate the precipitation data is. The model has been run with the generated daily time series and with measured precipitation for the Sardinian basins which contain operational stations (Cau et al., 2002). The model outputs were then compared in order to estimate the uncertainty introduced by such a downscaling procedure. The water budget results for a 20-year simulation period showed an average difference of 7% (with a range from 0.1% to 20%). Summer periods, characterized by few but intense events, were the most critical. The correlation coefficient for monthly water budget estimates using measured and synthetic data was 0.94, with no systematic error."

8. "The authors do not again demonstrate whether the streamflows were modeled accurately. All they have done is to state that they obtained a Nash-Sutcliffe value of 0.77. It is known that a high Nash-Sutcliffe index can be obtained when dry season flows are sometimes not correctly simulated. Did the calibrated model parameters enable accurate simulation of both high and low flows? Since synthetic daily precipitation time series were used, how accurately were the daily streamflow characteristics preserved? The paper has been presented in such a way that readers have to assume that all the modelling was done very well, which may not be the case".

For the remark concerning daily precipitation, we refer to the previous point. For the rest of this comment (and in response to some of the comments of Reviewer 2), we have significantly revised subsubsection 2.3.4, "Calibration" (formerly subsection 3.3, "Model calibration"), adding a new figure (now Figure 5), 2 additional references, and the following new or revised texts:

"Monthly streamflow and reservoir water level historical records were used as control values. The soil parameters adjusted during the calibration process, within ranges suggested in the literature, were AWC (available water capacity, ś 0.04), CN (curve number, ś 10%), and ESCO (a compensation factor that controls the evapotranspiration, up to 1) (Eckhardt and Arnold, 2001; Vandenberghe et al., 2001). A total of 120

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calibration parameters were activated (40 soil profiles x 3 parameters).”

“The calibration proceeded in the following manner: 1 (initial state), the SWAT model was run on 16 watersheds to obtain an initial comparison between simulated and observed streamflows; 2 (calibration), a subset of 3 watersheds possessing all of the soil profiles was used to calibrate the three soil parameters; 3 (validation), the adjusted parameters were accepted only if they improved the quality of the simulation for all 16 watersheds compared to the initial state.”

“In Figure 5 we also compare the measured and simulated monthly streamflow statistics (mean, standard deviation, and skewness) for the 70-year regional calibration. The annually averaged streamflow values of model output and measured data for the 70-year time period were 5.0 and 4.7 m3/s, respectively, while the annually averaged standard deviations were 3.8 and 4.5 m3/s, respectively.”

9. “The authors again present the results of modelling nutrient and pesticide concentrations, without any comparison with measured or observed concentrations. They do not present evidence to convince the readers that simulation of nutrients and pesticides was done accurately.”

Unfortunately there is no water quality data for the Mogoro and Flumini watersheds, despite their importance for the Arborea region. We thus relied on literature values for water quality parameters, supplemented with qualitative information obtained by querying regional and local agencies about agricultural practices. On this note, we have added to the new subsubsection 2.3.3, “Scenarios”, the following paragraph:

“The CORINE land cover possesses little information about land management practices and its changes (e.g., seasonal and yearly). Furthermore its low spatial resolution is not ideal when examining intensive agriculture applied at a parcel scale. Diffuse pressures must be consequently assessed using heterogeneous information sources. In this study a part of the work was to integrate and cross validate the land use spatial information of the CORINE map (to each combination of land use/soil there corresponds 1 HRU within the subbasin) with information from regional and local agencies about agricultural practices (areas cultivated, crop types, etc) at the local scale. From this investigation we were able to obtain data concerning fertilizer and pesticide types and quantities in each subbasin that could be input to the model."

With the water flow component of SWAT calibrated and verified to a satisfactory degree, and with representative values for water quality parameters, we assume that the transport component of SWAT will yield results that, albeit perhaps not accurate from a perspective of comparison with on-site data, are nonetheless representative of nutrient and pesticide impacts for the basins under consideration. For the aims of illustrating the model/DSS synergy and application, we feel that this approach is adequate. Moreover the results can be used as a basis for discussion with regional (Sardinian) water and environmental agencies, drawing attention to the importance of monitoring data, quantitative analysis tools, and the potential impacts of alternative resource management options.

10. "It is suggested that letters representing variables, coefficients and constants used in equations be written in italics in the main text to avoid confusion with the ordinary use of these letters."

OK, done.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 4, 747, 2007.