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Hydrology and Earth System Sciences Discussions

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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Overall, the two referee comments concern three aspects of our paper: how the paper is organized, some issues with the presentation and quality of the data, and some remarks on the simulations, in particular the calibration of the model. As described in our itemized response below, we have modified the paper quite extensively in response to the remarks of the reviewers on these three main themes, and on several other points as well. As there are some ripetitions in the comments of the two reviewers, we will remind to the first when needed to simplify the contents of the responces. Therefore items starts from 11.

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11. “Firstly, a description of the catchment-HRU configuration and a map is required. How were HRU’s derived and how many are there? Have the authors simply followed some automated GIS process of combining land and soil information? Are all identical HRUs lumped for modelling purposes or are they truly spatially distributed and then modelled separately with the output from each (streamflow, nitrates etc) routed according to the stream network. How are abstractions and reuse accounted for in the model? How do the authors link the output with the streamflow gauges for the calibration exercise?”

The HRUs are a combination (overlay) of soil and land use. For our purposes, the land operations that cause diffuse pollution are applied on the basis of the land use map only. In the calibration procedure, each soil parameter is changed for each soil type and not at an HRU spatial scale. This is necessary because we want soils to maintain the same characteristics. A catchment-HRU map would consist of 401 subunits (125 and 276 for the Mogoro and Flumini subbasins, respectively), being just the combination/overlay of the soil and land cover maps shown in Figures 3 and 4. Another figure would not add much additional information.

In subsubsection 2.3.1, “Soil and land cover” (formerly subsection 3.1) we have added the following additional information concerning the HRUs in the first and third paragraphs:

“The first step was to partition the watersheds into subunits. SWAT allows several different subunits or objects to be defined within a watershed: subbasins, HRUs, ponds, reaches/channels, and wetlands. Information about the geometry of the basins was extracted from a 400 m elevation grid and the river network. The minimum drainage area assessed by the AVSWAT preprocessing tool was 2500 hectares. With this threshold the Mogoro and Flumini watersheds were subdivided into 7 and 11 subbasins, respectively.”

“With this data, the Mogoro and Flumini subbasins were subdivided into 125 and 276

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HRUs, respectively."

The calibration exercise has been clarified (see point 8). For the routing and links to streamflow gauges, see point 14 below.

12. "Similarly, it is not clear how the climate input data are allocated/weighted for each HRU? With regard to rainfall data, the authors need to show that the disaggregation of monthly rainfall to daily is sound by comparison to observed data from the available raingages. At the least, mean monthly and annual values should be preserved in the synthetic daily rainfall file."

In the paper we state, in subsubsection 2.3.2, that "The daily synthetic precipitation for each month of each year of each station was then scaled to match the monthly registered rainfall". For the other comments, see point 7.

13. "It is not clear what the time-step for the observed streamflow data is - is it annual? Or monthly? It seems to be annual, but there is a statement that the timing and magnitude of seasonal water yields was captured - but then, what is the benefit of using a daily model in this exercise?."

In subsubsection 2.3.4, we state that "Monthly streamflow and reservoir water level historical records were used as control values." We agree that in this paper we do not fully exploit the daily model. SWAT was selected for the overall project which this work is a part of.

14. "The model is being reported as being calibrated following a 'regional scale approach' - this needs clearer explanation in the light of my questions regarding the spatial representation of HRUs above - and in particular, how these are linked with the streamflow gauges."

The calibration section has been significantly revised, as described in point 8. For further clarification on the HRUs and streamflow routing, we have added the following paragraph to subsection 2.1, "SWAT model":

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"Hydrological processes are first simulated in SWAT for the land phase at the HRU spatial unit. This yields the water, sediment, nutrient, and pesticide loadings to the main channel in each subbasin. In a second phase, the water, sediments, etc are routed through the channel network of the watershed to the outlet. For each subbasin there is one reach, one outlet, and many HRUs. Water quality and quantity states are given for each outlet at a daily temporal scale."

15. "The authors state that changes in the values to the parameters (AWC, ESCO, CN) were only accepted if they resulted in an improvement in the N-S index - but what was the basis for changing these parameters? [Ě] Thus there should be no need to change these parameters. In reality there is always some degree of 'parameter tweaking' that takes place in such modelling. However, to alter these parameters merely to improve some measure of statistical fit flies in the face of attempting any physical representation of the catchment, particularly if the N-S index is calculated on an annual basis. Are the changes in values for these parameters within the ranges suggested by the model developers? [Ě] Typically, the approach in similar modelling studies is to calibrate at one streamflow gauging station and validate [Ě] at another nearby, or to split the observation sample and calibrate on one half and validate on the other. The approach followed here does not provide any basis for extrapolation beyond the range of the calibration exercise. This is critical to the rest of the paper as I do not believe that there is any valid basis on which to accept the simulation output. Furthermore, it is implied that because the water balance is 'adequately' represented that the water quality output is acceptable- this is not true. Thus, there is no confidence in the pesticide or nitrate output unless some other form of validation is provided. Calibration of the model to represent the water balance is only the first step in a model validation exercise. In the context of this study, the authors also need to extend this work to include the water quality parameters."

In the much-revised "Calibration" section (see point 8): the calibration parameters and the range of values used is more clearly explained; in addition to the N-S index we now

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also present monthly streamflow statistics; and the calibration/validation split we used is described.

On the water quality issues, similar points were raised by Reviewer 1 (see point 9).

16. “Layout and logical order is poor. Often information that the reader requires appears later in the paper e.g. time step of the study.”

With the reorganization of the paper described in point 1 we feel that the paper now follows a more logical order.

17. “The figures are poor. Firstly, for an international audience a better location map is required. Secondly, the legends etc from the GIS derived map are far too cryptic and will make little sense to most readers. The authors do state that the USDA and FAO guidelines were used, but few people carry these in their heads. Why not simply provide something most readers can interpret e.g. sandy clay, deep sand etc rather than VT003/VT004 etc. Similarly for the landuse - what is AGRC or VINS provide something the reader can understand. A map showing the HRU’s must form part of the paper. Why are weirs/runoff measuring sites not shown. What is the difference between climatic and rain gauges?”

The inset in Figure 1 now shows Italy and Sardinia, with a black dot for the study area within Sardinia. This figure is now also cleaner, and the river network now appears in the legend. The legends for Figures 3 (land cover map) and 4 (soil map) now use more common terms. The caption for Figure 4 has also been made more descriptive, given the importance of soil parameters in this study. For the HRU map see point 11. An additional regional scale map to show the streamflow gages referred to in the calibration section would not add much information to the paper. In Figure 3 “climatic gages” refers to regional meteorological stations instrumented for rainfall and other atmospheric data. This is now explained at the beginning of subsubsection 2.3.2, “Climate characterization”, where we have added the sentence “Temperature and solar radiation data were gathered from 7 climatic gages within the study area (Figure 3)”.

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18. “The literature used is not adequate. There is a wealth of literature on the application of SWAT and similar models. The authors need to access these and consider their findings/recommendations, particularly in the context of the comments re: model calibration/validation above.”

We have added two references to the literature on SWAT applications (see point 8). On our findings/recommendations, and more generally on the context and contribution of our work, see point 5.

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