Hydrol. Earth Syst. Sci. Discuss., 2, S1465–S1468, 2005
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European Geosciences Union

Hydrology and Earth System Sciences Discussions

Interactive comment on "Multi-criteria assessment of the Representative Elementary Watershed approach on the Donga catchment (Benin) using a downward approach of model complexity" *by* N. Varado et al.

N. Varado et al.

Received and published: 1 March 2006

Comments:
5.1 + 7.11 and 7.16
Table 4 was completed in order to present all parameters and their values used in this application of the REW model. The ones missing on the previous table compared to table 5 from Reggiani and Rientjes were mainly the one from Leopold and Maddock (1953). In my PhD work, the model was found not to be very sensitive to these parameters. I used the default values found in Leopold and Maddock (1953). Only the "at-a-station" exponents could be determined with the data from the Donga Pont station. All other parameters concerning the geometry of each REW are not presented

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as they are calculated in the pre-processor part of the model for the Digital Elevation Model (DEM). This is done via the TARDEM model (Tarboton, 1997) as is explained in Reggiani et Rientjes (2005). This model extracts the river network and calculates for instance the REW slope and surface, the river slope, the length of the river link, the position of the centroides, the average bed elevation, etc.

5.2 +7.17: The routing part of the rainfall-runoff processes.

I'm not sure I really understand the referee comment. I don't understand if it deals with the routing part in the river network or on the surface runoff. For sure there is a routing process in the river network, by the momentum conservation equation of the river zone, which is similar to a kinematic wave approximation of the Saint-Venant equations. The river processes are particularly well described in Reggiani et al. (*2001: Coupled equations for mass and momentum balance in a stream network: theoretical derivation and computational experiments, Royal Society Proceedings, vol 457, pp: 157-189*). The similarity with a kinematic wave equation can be seen in Zhang and Savenije (*2005, Rainfall-runoff modelling in a catchment with a complex groundwater flow system: Application of the Representative Elementary Watershed (REW) approach, Hydrology and Earth System Sciences, vol 9, n°3, pp 243-261*) If the routing part of the surface runoff is concerned, we can argue that the velocity of this overland flow is calculated by the Manning-Strickler relationship. But I personally think that at the REW scale, most of the surface runoff is re-infiltrated towards the unsaturated zone.

Concerning the delay between the beginning of the rainfall and that of the discharge, there are different ways to explore the inability of the model to capture it. One can say that the way the discharge is routed can be improved. But I do not think it is the main cause of the problem. Parameters' variability across REWs is certainly something to be explored, such as the variability of the major processes such as infiltration or surface runoff, as the upstream catchments seem to be more subject to hortonian runoff than the downstream part of the catchment, more subject to runoff on saturated surface.

5.3

The position of the humidity measurements in the first meter of soil was added to the revised version of the manuscript. The degree of saturation presented in Figure 9 is global and calculated from the 6 sensors. However, I did not want to give many details of the measurements techniques because these measures were used in the very final part and were not part of the study when I performed it. They will be presented in future articles more based on local scale measures performed on the Donga catchment.

For sure the comparison of the soil saturation degree is a rather difficult exercise as the observations are point scale measurements and the simulated values are REW-scale values. This is why I did not put the two curves on the same graph. Furthermore, the mean depth of the unsaturated zone in the REW model is of several meters (few meters to a dozen of meters). On the contrary, measurements are done only on the first meter of soil and, from recent observations done in various points of the catchment, only the first meters of soil seem to participate to the discharge. Nevertheless, in both cases, it deals with the contributive part of soil to the general dynamics of the catchment. For sure, this comparison has to be done with caution and is only a first sight of the soil moisture dynamics. But I decided to keep it in the revised version of the manuscript.

Concerning the mean of the measured K_s, the arithmetic mean was used (added in the revised version). The geometric mean would have led to the same order of magnitude. In my opinion, a better way to calculate a mean Ks value would have been to calculate it by kriging. However, the sampling should be performed with a finer spatial resolution. Indeed, with the available spatial sampling (one point every 0.1°) , no spatial correlation between points could be identified. Another way would have been to weight the measures by an area of influence, but it remains quite unknown.

7.18

As explained in the manuscript, the calibration was done manually, on only two parameters. The difficulty to capture the delay of three months can be partly explained by the calibration procedure. Additional work on parameter estimation, via an automatic calibration may help in better represent the delay. It is true that the saturated surface area is well developed during the whole year. For example, on REW n°1, the mean saturated surface fraction is around 0.20, with a minimum at 0.135 and a maximum at 0.334. During my PhD, I worked on better describing the relationship between the saturated fraction and the water table level, for example using the topographic index or so. But it did not lead to interesting results deserving publication. It is true there is no exchange between Zone C and Zone O. Nevertheless, the fraction of saturated area varies in time and so represents the link between the two zones; and the infiltration excess overland flow is considered by Zone C.

Figure 10 was redrawn in order to compare directly depths with respect to the soil surface of the REW and the wells' surface. The average REW elevation is at 343.94m whereas the elevation at Ananinga, Foyo and Gaounga wells is respectively 385.67, 369.84 and 387.65m a.s.l.. This information was added in the revised manuscript and will probably help in the understanding of the figure and the conclusions.

All modifications and suggestions concerning spelling and styles were taken into account in the revised manuscript.

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 2349, 2005.