Hydrol. Earth Syst. Sci. Discuss., 9, C2689–C2695, 2012
www.hydrol-earth-syst-sci-discuss.net/9/C2689/2012/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Usefulness of four hydrological models in simulating high-resolution discharge dynamics of a catchment adjacent to a road" *by* Z. Kalantari et al.

Anonymous Referee #1

Received and published: 2 July 2012

GENERAL COMMENTS

The presented article is a systematically performed study on modelling runoff from a small catchment adjacent to a road. The value / novelty of the article mainly is i) in concentrating on winter time conditions that often are neglected even in studies in cold climate regions, and ii) in using and comparing the performance of four structurally different hydrological models. The main concerns related to the overall quality of the article are i) the difficulty to picture runoff generation in the study area, and thereby the difficulty to assess the results and the presented analysis on the performance of the different models, ii) some inconsistencies related to the calibration and evaluation of the models: after carefully reading the article it still is not completely evident what data was used for what and why, and iii) no references to preferential flow even though it often plays a crucial role in runoff generation in Scandinavian soils. The concerns are elaborated in the following in the "Specific comments".

SPECIFIC COMMENTS

Purpose and objectives of the presented study are clearly presented and explained. However on p. 5124, ll. 24-26: How do the hydrological events (the word period used later for the three different datasets) "snowmelt" and "partially frozen soil" differ from each other? Please insert a short description to clarify what is meant by these events / periods in this study. The soil supposedly is at least partially frozen during snowmelt, so is the difference that during the event "partially frozen soil" there is no snow? There is some explanation to this from p. 5140 on, though a short explanation already in the Introduction would clarify, what actually is investigated with the models.

Chapter 2.1, p. 5125: A map of the area, showing the land-use and soil types, topography, as well as the location of the road with its drainage constructions, would help in picturing the area and the circumstances for runoff generation, and in assessing the results and the analysis of the models. A short description of how runoff is affecting the drainage construction would also be helpful: what part of the runoff is expected to enter the drainage system and by which mechanisms – only surface runoff important for the drainage system?

The CoupModel apparently is the only model in this study that directly includes soil frost. Please highlight this on p. 5127, for instance on l. 4, after saying "Our search for hydrological models resulted in the selection of four models that met the stated criteria" – one of the criteria being "the models had to be applicable to catchments subject to winter conditions with frost, snow and frozen soil" (cf. p. 5123 ll. 25-27). The other three models include the effect of winter conditions by snow and snow melt, or

HESSD

9, C2689–C2695, 2012

by changing parameter values (like the K-sat value) so that infiltration and unsaturated flow is delayed to include the effect of frozen soil.

Chapter 2.2.3, pp. 5129-5130: The CoupModel is presented in less detail than LISEM and MIKE SHE. Please insert at least a notion of dimensionality of the CoupModel (1D?) and a short explanation on how the flow is directed in the model to generate runoff.

Considering the order of Chapters 2.2 and 2.3: Table 1 listing the main features of the models is very informative. While reading through Chapter 2.2, many questions arise that are then answered when reaching section 2.3 and a reference to Table 1. I was, for instance, asking that which models do describe soil frost directly: There was only a statement about MIKE SHE in Chapter 2.2.2 that it does not describe it. Therefore, I recommend moving the reference to Table 1 right before Chapters 2.2.1-2.2.4. Chapter 2.3 could actually be removed and the few sentences in it could be moved into Chapter 2.2.

Generally referring to all the four models presented in Chapter 2.2, and in relation to the modelled events: how do the different models describe preferential flow? At least the CoupModel includes a simple by-pass routine for preferential flow that can by-pass the soil matrix. Depending on the location of the different soil and land use types in relation to the catchment outlet / the road, vertical and lateral preferential flow as well as subsurface stormflow may be significant contributors to the generation of the flow peak, in addition to overland flow. There is a bunch of studies on modelling preferential flow in Nordic conditions (e.g. Espeby 1989, Jansson et al. 2005, Gärdenäs et al. 2006, Laine-Kaulio 2011, Warsta 2011; see the end of the review). If you are certain that preferential flow can now be ignored in the analysis, please include a short statement, why, in the Introduction and/or the Methods section. In the opposite case, I'd recommend shortly discussing the effect of preferential flow on runoff generation and the model outcomes throughout the article.

HESSD

9, C2689–C2695, 2012

Interactive Comment

P. 5133 ll. 24-25: What were the runoff generation mechanisms? Insert a short description. If they are explained later, consider inserting here a reference to that chapter.

P. 5134 ll. 6-8: In addition to the lack of spatially distributed, measured parameter values, an even bigger problem often is the lack of measurement methods that describe the parameters reliably in the same scale as the model needs them. For example water retention data (-> unsat. hydraulic conductivity) as well as saturated hydraulic conductivity often are determined from soil core samples that produce an estimate way too small compared to the conductivities of larger scales (meters to tens of meters). One reason behind this is that the soil core samples do not include the effect of preferential flow and formation of subsurface stormflow on the conductivity estimate. The effect of cracks and fissures (especially for claye fields) as well as root holes, soil pipes formed by soil fauna and erosive action and stone surfaces (especially for forested moraine soils), affect both the parameter values and the runoff generation phenomenon vs. the model structure required.

P. 5135 ll. 17-21: Are you lowering the K-sat value of the top layer to prevent water infiltrating into the frozen soil, and, thereby producing more overland flow, forcing the runoff to compose more of water flowing on the soil surface? A direct statement of this would be good.

Chapter 2.5.4: Was the CoupModel using the by-pass routine to generate subsurface, preferential flow? Were the parameters guiding the by-pass flow among the calibrated ones?

After reading pp. 5134-38: Why were the calibration periods of the models different, e.g., why is all the data taken into account when calibrating the CoupModel with the MC procedure (p. 5136 ll. 24-25)? When later analyzing the simulations further, is the general, better performance of the CoupModel and HBV mainly a result of that that all the data were used for finding the best parameterization, whereas the parameterization of the LISEM and MIKE SHE were tuned with only one event in one period?

HESSD

9, C2689–C2695, 2012

Interactive Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

P. 5140 ll. 10-12: There is no validation period for the LISEM, and the model is only evaluated against the data used for the model calibration: this could be stated directly already in the beginning of the Calibration Chapter.

Pp. 5141-5143: The use of words calibration, evaluation, etc.: would it be possible to define these concepts already in the methods section. And also explicitly tell what period or what event in a period was used for what related to each of the models. Now it is slightly difficult to find this information scattered in the calibration and results chapters.

P. 5145 ll. 1-2: I'd suggest mitigating the trivial message somehow, only noting for instance "Despite the common differences in measured and modelled runoff values, the timing of simulated and observed . . . . . . in this study."

P. 5145 ll. 4-9: Does this now mean that the goodness of fit measures in table 3 contain the whole simulation period (containing periods I, II and III), or do they describe the calibration period that is(?) the first event in the period I, or different periods for different models? Please make clear what is behind the values.

P. 5146 Chapter 4.2: How about the effect of preferential flowpaths on infiltration? Models used do not describe this mechanism in enough detail?

TECHNICAL CORRECTIONS

P. 5122 ll. 5-7: the sentence difficult to understand. Could it be re-written in a more understandable form so that the subject of the sentence, before the predicative, is not two lines long?

P. 5127 ll. 3-4: consider repeating here the criteria for selecting the models for this study (they were listed in the Introduction on p. 5123).

P. 5128 ll. 1-2 and ll. 8-9: the same sentence about infiltration repeated.

Table 1, the independent input data for LISEM: "distributed input" repeated.

P. 5133 l. 6: a dot missing between “data” and “Vegetation”.

Table 2, referred to on p. 5133 ln 23: Model names LISEM and MIKE SHE repeated in the table. Correct the names at the lower half of table to Coup model and HBV.

P. 5133 l. 26 vs. ll. 28-29: edit the sentences such that it is directly stated which event refers to which dates / periods.

P. 5135 l. 15: Reference to Fig.3: are the soil temperatures measurements or simulated with some of the models? If they were calculated with the Coup model, please mention it at least in the title of the figure. After having read 5 pages further, it is said that the values are calculated - if they however are measurements, I suggest replacing “results” with “observations”.

P. 5135 l. 19: Table 3 should be Table 2?

P. 5136 l. 23: word “as” missing between words “period” and “MIKESHE”.

P. 5139, reference to Table 3: complement the title of the table to include the information that the values are for the calibration period (as mentioned on ll. 6-8), and also tell explicitly what is the calibration period. Where are the R2 and NSE values for the validation / prediction period? Consider including those values in the same table as well, even though you use the peak flow residuals as the main criteria to analyse the errors in predicted discharges (cf. p. 5142).

Chapter 3.2: Insert subtitles similarly than in previous Chapters?

P. 5140 l. 15: reference to Figs. 3, 5, 7 -> should they be 3, 5, 6?

P. 5141 l. 11: typo in the word “hydrograph”

P. 5141 l. 13: word “optimised” rather “calibrated”?

While reading pp. 5140-41 and looking at Fig. 3: to clarify what is meant by “period” vs. “event(s)”, and which event in period is used for calibration and which for validation

/ evaluation, insert a statement to the title of the figure directly telling that event on 10-12.1 is used for calibration (if this is the case) and events on 13-18.1 for evaluation.

References to studies taking into account the effect of preferential flow in Nordic conditions:

Espeby, B. 1989. Water Flow in a Forested Till Slope – Field Studies and Physically Based Modelling. Dissertation. Royal Institute of Technology, Department of Land and Water Resources. Report Trita-Kut No. 1052. Stockholm, Sweden.

Jansson, C., Espeby, B. and Jansson, P. E. 2005. Preferential water flow in a glacial till soil. Nordic Hydrology, vol. 36 (1), pp. 1-11.

Gärdenäs, A. I., Šimůnek, J., Jarvis, N. and van Genuchten, M. Th. 2006. Two-dimensional modelling of preferential water flow and pesticide transport from a tile-drained field. Journal of Hydrology, vol. 329, pp. 647-660.

Laine-Kaulio, H. 2011. Development and analysis of a dual-permeability model for subsurface stormflow and solute transport in a forested hillslope. Aalto University publication series, Doctoral Dissertations 71/2011. Aalto Print, Helsinki. 192 pp. Available at: http://lib.tkk.fi/Diss/

Warsta, L. 2011. Modelling water flow and soil erosion in clayey, subsurface drained agricultural fields. Aalto University publication series, Doctoral Dissertations 82/2011. Aalto Print, Helsinki. 209 pp. Available at: http://lib.tkk.fi/Diss/

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 5121, 2012.