Hydrol. Earth Syst. Sci. Discuss., 7, C1379–C1383, 2010
www.hydrol-earth-syst-sci-discuss.net/7/C1379/2010/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Effect of DEM resolution on SWAT outputs of runoff, sediment and nutrients" *by* S. Lin et al.

Anonymous Referee #2

Received and published: 11 July 2010

– The paper investigates the effect of varying DEM resolutions an several topographic-hydrologic parameters which are fed into the semi-distributed Soil Water and Assessment Tool (SWAT). A high resolution contour line dataset, the relatively new ASTER GDEM and v. 4 of the well-known SRTM elevation dataset are used as base data sets. From these several differing resolutions are interpolated with bilinear interpolation and then submitted to SWAT. The results are compared using the highest resolution data set as a model baseline.

– The paper investigates partly well-known phenomena (e.g. impact of DEM resolution on slope gradient) but extends the scientific discussion I am aware of by looking at several other (less researched, I think) parameters and results of SWAT. In my opinion,

the three biggest shortcomings of the paper are the following (and these would need to be addressed before the paper can be accepted for publication):

1) Inclusion of more relevant literature:

To me it seems that the authors don't rely much on literature in the field of digital terrain modelling and resolution sensitivity of various topographic terrain parameters. Maybe the authors focussed their literature search and review too much on authors who specifically investigated SWAT rather than terrain parameters such as gradient in general. I definitely second point 10) raised by anonymous reviewer #1 regarding the literature.

2) More detailed and concise description of SWAT:

Not knowing SWAT I found the description of the model structure and the inner workings should be more detailed. As of now, I also have the impression that the model's workings are touched upon from time to time in the text, so that it is difficult for the reader to assemble all these bits of information into a coherent understanding of the model. Ideally, the authors would strike a balance between giving enough information as to understand the model's workings and not giving too much detail which would not add to the reader's understanding. Having enough information on the model's functioning would ideally enable the readers (and the authors!) to understand how the different DEM resolutions affect the model's results. As of now this remains a black box. In this respect I seem to be supporting the discussion points 3) and 4) by anonymous reviewer #1.

3) More in-depth analysis and discussion of the results:

I take from the text that SWAT is a semi-distributed model. However, the investigation of resolution-induced differences remains wholly a-spatial. I think that (if possible) mapping some of the probably a-spatially derived model properties back into space and looking at *spatial* distributions of parameters and model factors could be insightful.

As the text stands now, I feel like only half of the story may be told; we get to know about statistical distributions of model results, but we don't know about their spatial distributions. Seeing the latter may, however, help in explaining the former.

– In the following I will adress certain points a bit more specifically.

– Starting from line 6, p. 4423 there is a citation error. Quote:

"Previous studies showed inconsistent results about the effects of original resolutions on SWAT predicted runoffs. Some found that runoff decreased with coarser original DEM resolutions (Wolock and Price, 1994; Cho and Lee, 2001; Di Luzio et al., 2005), some did not (Bosch et al., 2004; Dixon and Earls, 2009)."

In my impression, this paragraph implies that Wolock and Price researched resolution effects on SWAT model performance. However, this is demonstrably not true! The work by Wolock and Price was about TOPMODEL (http://dx.doi.org/10.1029/94WR01971), not about SWAT. (Of course some of the input parameters of these two models are identical)

– Regarding literature I encourage the authors to look at for example the following:

Kienzle S. W.: The effect of DEM raster resolution on first order, second order and compound terrain derivatives. Transactions in GIS 8 (2004) 83-111

Zhang W., Montgomery D. R.: Digital elevation model grid size, landscape representation, and hydrologic simulations. Water Resources Research 30 (1994) 1019-1028

Bruneau P., Gascuel-Odoux C., Robin P., Merot Ph., Beven K. J.: Sensitivity to space and time resolution of a hydrological model using digital elevation data. Hydrological Processes 9 (1995) 69-81

Brasington J., Richards K.: Interactions between model predictions, parameters and DTM scales for TOPMODEL. Computers & Geosciences 24 (1998) 299-314

Vieux, B.E.: DEM aggregation and smoothing effects on surface runoff modeling. Jour-

nal of Computing in Civil Engineering 7 (1993) 310-338

Gao, J.: Resolution and accuracy of terrain representation by grid DEMs at a micro-scale. International Journal of Geographical Information Science 11 (1997) 199-212

Thompson J. A., Bell J. C., Butler C. A.: Digital elevation model resolution: effects on terrain attribute calculation and quantitative soil-landscape modeling. Geoderma 100 (2001) 67–89

Wilson J. P., Repetto P. L., Snyder R. D.: Effect of data source, grid resolution and flowrouting method on computed topographic attributes. In: Wilson J. P., Gallant J. C. (eds.): Terrain Analysis. Principles and Applications. John Wiley & Sons, New York (2000) 133–161

– Regarding your interpolation scheme: Can you reason a bit more as to why exactly you chose this methodology? Why do you use a TIN-based interpolation for the contour line data? Does this have negative effects on the quality of the DEM? Did you try contour-specific interpolators such as ANUDEM?

Is it sensible (or under what conditions is it sensible) to interpolate SRTM data at 3 arcseconds onto a 5m grid? What effects are to be expected?

– What is the information content of your input DEMs? On that note I encourage you to have a look at the distinction between nominal and real resolution in Straumann and Purves (2007).

Straumann R.K. and Purves R.S. (2007): Resolution sensitivity of a compound terrain derivative as computed from LiDAR-based elevation data. In: Fabrikant S.I., Wachowicz M. (eds.) Lecture Notes in Geoinformation and Cartography. Proceedings of AGILE 2007, 8.–11 May 2007, Aalborg, Denmark, 87-109.

In conjunction with this I think there is already a growing body of literature which examined the quality and information content of ASTER GDEM in more depth than the manufacturer's specifications (e.g. "Is the resolution of ASTER GDEM really three

times higher than that of SRTM90?"). It would be nice if you could incorporate some of that research into the paragraphs on page 4417.

The notion of nominal versus real resolution might be helpful in explaining or underpinning some of the findings of your study as well as some partly contradictive results you included from the literature towards the end of your article. Some examples where thinking about said notion may be helpful are: first paragraph on page 4422, line 6 and following on page 4423, second paragraph on page 4426.

– I definitely second comment 6) by Reviewer #1 ("differences" vs. "errors" as well as absolute values). Regarding table 1 I suggest dropping the third to last column since it offers no information value at all. Think about including absolute values in this table and also about changing the order of columns (first REoriginal and then REmax-min, since the latter can be seen as a crude distributional parameter).

– Please work carefully through your manuscript to prune some more typos and poor English (some examples: "shaped terrains" line 2, p. 4418 / "did not sensitive to" line 28, p. 4421 / "runoff would not affected" line 12, p. 4422 / "from SRTM90m, flowed by" line 18, p. 4422 / "Result justifications" chapter heading 4.1 / "how differently input data" line 26, p. 4425 / "forest, which domains the land use" line 27, p. 4426).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 4411, 2010.