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Hydrology and Earth System Sciences Discussions

Interactive comment on "Global-scale analysis of river flow alterations due to water withdrawals and reservoirs" *by* P. Döll et al.

Anonymous Referee #2

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GENERAL COMMENTS

This paper presents modelled results of impacts of dams on river flows globally. The model is used to calculate runoff under current, and naturalized (without dams and water usage) conditions. The focus is on flow variability. An estimate on the reduction in fish species is also shown. The work is a continuation of earlier work by e.g. Vörösmarty et al. 1997, Nilsson et al. 2005, Haddeland et al. 2006, Hanasaki et al. 2006 and Palmer et al. 2008 on global analysis of dams and their impacts.

There are several questions especially about the methods that are not clearly explained or discussed. After these have been answered in the paper, it is well worth publishing.

WGHM is a calibrated model. It is not clearly stated in the paper how the calibration was handled in the different model runs. Several clarifications are needed about the calibration. Is the model calibrated to the standard (ANT) run, or is any calibration made also for e.g. the naturalized flow run? If the latter is not the case, which I suppose, please discuss the possible impact of your results for the ANT LAKE, USE, RES and USE runs when the calibrated parameter value comes from the ANT case. And if not, please discuss the implication when comparing results from runs with different calibration parameters. Was the model calibrated again compared to the Hunger and Döll paper, and what were in that case the differences? Were the four validation basins used in the calibration or not? If not, was there any calibration made downstream in those basins, or are the gauging stations totally independent?

I appreciate the last sentence in the abstract pointing out the uncertainties in this study.

The paper is well written, but personally do I prefer a somewhat different order of presentations. Answers to my question marks often come one or two sentences below. As an example the model efficiency is introduced 2-3 rows above the specification that this is the Nash-Sutcliffe coefficient.

SPECIFIC COMMENTS Please answer the questions below in the revised version of the paper, even if I did not add "Please explain" to every question.

Abstract, l. 6: Stating that this is the first study is for me a little bit too strong, thinking of e.g. Vörösmarty et al. (1997). You may still use "first" but please rewrite such that your particular contribution (flow variability) comes in closer connection to "first".

4777, l. 15: 4000 km3/yr, is this value consistent between different estimates (WaterGAP, the model by Hanasaki, purely data-based estimates etc.) or does it vary a lot?

4778, l. 20: Is the version 2.1g introduced with this paper? Please clarify this, and that Hunger and Döll (2008) is using version 2.1.f. Does "For this study . . ." (l. 22) mean

changes made to the model in version 2.1g? It is not sufficient that you write more about the version numbers on 4779 l. 26.

4781, l. 8: 2002? But the discharge is calculated for 1961-1990. What effect does this discrepancy in time have? And, how come that you later in this section show results for 1951-2002? How were these values calculated, and why do you not use the data from 1961-1990 in connection to the simulated runoff? Please inform better about the data sources you have used and their coverage in time, and please also discuss what effects the miss-matches in time might have. Do you try to explain something about this in the beginning of page 4785? If so, please move it to earlier in the methods description (it is actually hard to remember that the paper still is in the methods section after the references to figure 1, which easily are interpreted as results, and not background information). Additionally, your statement on p. 4781, l. 25-26 would be easier to understand if Fig 1b. also include information on dry years (maybe as thin, vertical lines), but then you also have to define what you mean by "dry years".

4782, l. 10-11: Are there cells which are emptied and stay emptied until the end of the simulation?

4783, l. 6: What is the reason for not checking the smaller reservoirs? Too time-consuming, data not accessible or are they really un-important? How do you expect the result to be influenced if these also had been included?

4783, l. 23: Why did you use different algorithms for the global and local reservoirs? Please explain.

4784, l. 6: "five downstream cells". Did Hanasaki et al. also use 0.5 degree cells, or did they use the larger 1 degree cells, i.e. does this procedure affect about the same area? It is somewhat unclear in this section what is different in the methods of Hanasaki et al. and your study and what is common.

4786, l. 8: "in river" => in large river. If they did not study large river basins, are the

results actually applicable here?

4786, l. 22: Is this equation applicable for the upstream basin of each cell, when it was calculated for the basin outlet only? Additionally, were there any unregulated rivers in the work by Xenopoulos et al.? If not, is the equation applicable when using naturalized flows?

4787, l. 8: Do USE and RES sum up to the NAT values? Why, or why not? 4793, l. 13: Are the effects non-additive for individual basins, but the results even out on the global scale?

4787, l. 18: Is this seen in measurements of the runoff too?

4788, l. 3: Is this decrease simulated by the model, or taken from some reference?

4790, l. 5: Seems to be contradictory to the delays of several months reported by Vörösmarty et al. 1997? Please explain. Additionally, how did you calculate the area on row 8? Is it only the area of the river, downstream of the dam as these values are so low?

4791, l. 20: Estimate too low also where you calculated a reduction of 99%?

4792, l. 12: Is the dam building/operation start time included in the model, such that the regulation is not used before this date?

4795, l. 7: What is different with ITS? (Should probably be discussed in the discussion section and not here.)

4795: Acknowledgement. Are the data by e.g. Haddeland freely available over the web or have you received them personally? In the latter case I think it is appropriate to add it in the acknowledgement, or otherwise you should provide a link. If any of your data providers requires to be mentioned in the acknowledgement, all should be mentioned.

TECHNICAL CORRECTIONS

Abstract, l. 12-15: Two comments: Clarify: “have decreased”, what time-period is meant? Suggestion: Divide the paragraph in two, to increase the readability.

Abstract, l. 20: “in areas with little consumptive water use that are downstream of dams” Unclear, please rewrite.

4775, l. 25-27: “Humans have . . .” Please provide a reference

4776, l. 7: “in recent years” - 1989 is not very recent for me

4776, l. 29: “regimes are” => regimes, are

4777, l. 4: “flow regimes”. I expect a list of references here, please add, or rewrite. 4777, 1.5: Your description of the work by Bouwer et al. (2006) does not say anything about biological impacts, as I expect from the sentence above.

4777, l. 22: Why is the section of the submitted Döll paper specified here, but not on row 15? I suggest removing the section specification here, as numbering of a submitted paper might change before publication, unless the formatting rules of HESS state something else.

4777, l. 27: “run-of-river dams”, please explain

4779: The difference between WaterGAP and WGHM is not clear here. On l. 8 WaterGAP is said to simulate water flows and storages, and then it comes again about WGHM on l. 12. A suggestion is to mention WGHM already in the first sentence.

4780, l. 19: “Five time series” => Five time series (ANT, NAT, RES, USE, ANT LAKE)

4781, l. 5-6: “non-renewable groundwater . . .” Please provide a reference

4782, l. 25: “of which are” => are

4784, l 3: Do you have information on operational year for the dams?

4785: Why are some references included in Table 2 and some in the text? It is confusing. Additional comments about Table 2: Table 2: I had several problems with this

table, also in addition with the text. It is good that you provide a description of your calculation, but equations would also be useful, as a complement. It would also be very helpful with columns defining min and max of the criterias (but without removing the explanation of -12, 10 etc. for IIV). ILF, definition: “in percent of naturalized . . .” is naturalized Q90 meant here, or the total naturalized flow? Is it a long-term-average or not? ISR, definition: are the 12 average differences calculated first, and then the average of these? What naturalized flow is meant (like for ILF). Tricky to understand. IIV: tricky to understand, especially as I missed the clue text “interannual”. A formula would be helpful.

4786, l. 2: at al => et al. (latin normally in italics as well)

4787, l. 24: 2a => 1a ?

4788, l. 13: “Nile downstream” => Nile just downstream – a suggestion since I understood this when reading as the whole of Nile downstream the Lake, and then you additionally write about the parts of the Nile further downstream. Alternatively, rewrite e.g. “several locations in the Nile”

4788, l. 24-27: Suggestion, switch order of the last to sentences as you just before had a large part about Q90 decreases.

4789, l. 13: “USA, or” => USA, and

4790, l. 24: Suggestion, new paragraph before “Interannual variability”

4792, l. 10: What are the sources of the naturalized flows in Volta and Volga?

4793, l. 19: “there are also stations”, in Colorado or globally?

4794, l. 23-25: “analysis where” => analysis, where “2.4% because” => 2.4%, because

4795, l. 26: 5%, does this refer to the total land area or, 5% of the area downstream of dams?

4798, l. 9: Dóll => Döll

Table 1: How do you define the border between Oceania and Asia?

Table 3: Table headers would be clearer if they were written on three rows, now the two rows in the header of column 2 are not really kept together. Remove the "-" in Indi-cator (if it is written on one row).

Table 4. "use CU" => use (CU). Tuning period could be added as a column to avoid several footnote rows. How did you set the tuning period? Are the tuning periods the same as the period with observed data, or have you used any other criteria to set the period as well?

Figure 3: Explain RMSE

Figure 4 and following: Explain that Qnat=0 means that the natural river discharge is zero, as this abbreviation is not used elsewhere in the text, and explain CVnat in Figure 7.

Figure 4: Tricky to distinguish light blue and grey.

Figure 9, US rivers: 7 lines but only three are explained in the figure. Please add the missing 4 lines.

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