Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2020-225-RC1, 2020

Geoscientific Model Development Discussions

Interactive comment on "The global water resources and use model WaterGAP v2.2d: Model description and evaluation" *by* Hannes Müller Schmied et al.

Anonymous Referee #1

Received and published: 10 September 2020

General comments

The authors provide a detailed model description of the latest WaterGAP global hydrological model and specification and validation of its standard output data. The model description part covers the entire model but puts extra weights on the improvements and advances since Müller-Schmied et al. (2014) which reported the last model updates. The standard output data part concisely compiles related information for the potential users.

WaterGAP is a great model that has lead the field of global water resources research for two decades. I believe this paper provides a foundation and a benchmark to the

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research community.

It is noteworthy that the model description includes the detailed procedure of hydrological parameter tuning. One of the distinct characteristics of WaterGAP is that the developers have conducted painstaking manual hydrological parameter tuning at more than one thousand basins. This feature brings a distinct performance compared to other global hydrological models (mostly untuned), but the procedure was virtually unseeable for non-developers since available descriptions were quite old (Döll et al., 2003; Hunger and Döll, 2008). The clear and detailed description in this paper will be helpful for understanding the outputs of WaterGAP, in particular, those who are interested in intercomparing models.

The disclosure of standard output should be highly appreciated. Although numerous model intercomparison projects have been conducted (e.g. WaterMIP, ISIMIP/global water), the performance of models tends to fall short of that of under the original (model-optimum) condition. The broad community will be benefited from the provided data.

The manuscript is certainly long, but well structured and written. The major contents are, as noted earlier, the description of the latest model and outputs which is essentially a summary of past six years of peer reviewed papers. Due to the nature of this manuscript, I haven't rigorously examined the methods and results one by one. Rather I have read and commented this manuscript from the viewpoint of a learner of the model and a user of the outputs. Hope the specific comments below are useful for further revision.

Specific comments

Line 11: This sentence is too long. Better to split into two or three.

Line 20 'Environmental Performance Index': This term needs a reference.

Line 86: 'Hyungjun' reads 'Kim'.

Line 137 ‘Cropping patterns and growing periods are generated for every year’: A bit confusing. The authors wrote that growing period is fixed at 150 days. What does this part mean?

Line 138 ‘the respective 30-year climate averages’: A bit hard to read. Which climate variables are year-specific and which are 30-year mean?

Line 265 ‘Increases in soil water storage in irrigated areas are not taken into account’: I am wondering how evapotranspiration from irrigated area is estimated in this model. I guess abstracted water for irrigation is directly added to evapotranspiration of a grid cell, but this should be clearly elaborated.

Line 318 Equation 7: Seems LAI was used only for canopy storage calculation. Is this really the case? I wish to see the list of variables which are directly affected by the daily dynamics of LAI. This point must be important to understand/interpret the outputs of WaterGAP model.

Line 611 ‘Unsatisfied water use is added to NAs of the next day until the end of the calendar year’: It sounds that this treatment can result in a quite unnatural hydrograph. For example, for the rivers affected by the monsoon system, the increase in wet season’s discharge must be substantially delayed, because the initial increase in runoff is used for the ‘repayment of water loan’ accumulated in the preceding dry season. Please consider adding a note on the consequences of this assumption/treatment which would be helpful for the readers. Finally, as a hydrologist living in an Asian country, I need to write here that this assumption/treatment is quite odd. The drastic seasonal change in water availability is the heart of the water scarcity problem in our region, which seems largely (if not completely) unaccounted by this model (see discussion in Hanasaki et al. 2008, HESS).

Line 629 ‘areal correction factor (CFA)’: Why is this term called ‘areal’?

Line 647 ‘For global water balance assessment the mass balance is kept by adjusting

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the actual evapotranspiration component': Does this mean that the actual evapotranspiration is simply calculated by P – Q?

Line 779 "NSE and logarithmic NSE": NSE is usually calculated between two time-series at a single location (e.g monthly simulated and observed discharge). How NSE in Figure 5 was calculated? Seems nation-wise NSE was calculated using five-year interval time series (i.e. the typical interval of FAO AQUASTAT is five-year), then averaged globally, but is this really the case?

Line 785 "However, NSE Values below 0 for 259 stations show the complete failure of WaterGAP2.2d to simulate streamflow dynamics in one fifth of the evaluated basins": I feel that this sentence is a bit unclear. What I understood is that monthly and annual variations were not properly reproduced for these 259 stations, although the simulated mean annual discharge agrees well with that of observation due to the calibration.

Line 775 "reasonable quality": I don't know what this phrase exactly indicates. The log-log scatter plot (Figure 5) is not very helpful for judging model performance. At least some additional notes are needed for the results of industrial sector (Figure 5e) which indicates frequent occurrence of two orders of magnitude overestimation between simulation and observation.

Line 938-945 "In case of negative NAs. . .": Highly technical and hard to read. It would be helpful for readers if the authors add links to the directly relevant model description parts (e.g. subsection or equation).

Line 949 Table 6: What does negative values for 'actual net abstraction from groundwater' indicate? Does it mean that groundwater recharge has been increased by humanities? I am quite confused because Table 7 indicates that the groundwater is being depleted globally. Similarly, add some extra notes for the negative values for 'change of total water storage' which look constantly increasing by time. What are the key reasons for this?

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