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Discussions

Interactive comment on "Small farm dams: impact on river flows and sustainability in a context of climate change" *by* F. Habets et al.

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"The paper on the modelling of small dams effect on inflow in France is interesting and handle correctly the issues inherent to modelling small reservoirs that are not present in statistics. Overall, the paper is well written, cites appropriately existing literature and present interesting results and methodologies. There is a major issue, however, on methodology description. Indeed, an element of the methodology remains unclear, namely, whether the water collected by small dams is only the runoff from precipitation or also rivers runoff for river going through the cell. The description of the methodology seems to imply that

only the runoff from precipitation is collected by the small representative reservoir, but since it is also said that water from rivers is used, it remains unclear. A sentence says: The small farm dam module was connected to SIM with a daily time step by collecting both the simulated surface runoff and infiltration (Fig. 2). But at other places, there is a reference to water from rivers being collected. This should be stated more clearly.

Indeed, the text could be misleading. The small farm dams are expected to collect water that flows in brooks. Such brooks are too small to be simulated by the model explicitely. However, it is expected that the runoff and infiltration simulated by the model can be used to estimate the flow that is captured by the small farm dams. As these fluxes are the inflow of the main rivers the fact that part of these fluxes are stored in small farm dams directly impact the flow of the main rivers (river that are large enough to be simulated by the model).

To improve this point, it is now written:

- Introduction: *"Although irrigation dams can be large, most of them are associated with reservoirs of small storage capacity located on farms, and thus usually not connected to the main rivers, but connected to small brooks."*
- section 2.2: *"Altough it is not always the case, the reservoirs are considered to be filled up by capturing small brooks (even, temporary brooks). These brooks are not explicitly represented in the model, but the water that flows in such brooks can be estimated by considering the surface runoff and infiltration produced on the corresponding watersheds. Such approach is not fully compatible with the small farm dams that fill up by pumping from rivers. Such dams are then able to collect water from a larger area than the small dam's catchment, and the chosen modelling approach will then tends to underestimate their filling ability."*

Another related issue is that what determines the quantity of inflow is collected

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by the representative dam is never clearly said. My understanding is that the share of cell covered is translated to a share of inflow collected, but it is not said anywhere, or not clearly enough.

The dams are supposed to collect all the water from that flow in their catchement during the filling period, as long as the dams are not filled up. Indeed, this hypothesis is compatible with the managment of these small farm dams, since there is no commitment to assure a minimal flow in the collected brooks (as they may be temporary brook). However, a maximum inflow was set to 1 m^3/s (p 7, line 25). This maximum inflow was set in order to be compatible with those small farm dams that fill up by pumping. However, this limit is not a big constraint, as this threshold is barely reached in the small catchement area of the dams.

To make it clearer it is now stated at the end of section 2.2: *"The small farm dam module was connected to SIM with a daily time step by collecting both the simulated surface runoff and infiltration that flow in their catchment areas. All the flow can be captured as long as it is below the 1 m^3/s threshold and that the dam is not yet filled up."*

Also there are reports of significativity all over the paper, it is unclear to me how it is computed. It would be relevant to explain it formally once.

It was written section 3.3.3 "The significance of the results was estimated using a bootstrap approach." To better explain this part, a section 2.3 Assessment method is added. It is now stated in this section: *In order to establish if the impact of small farm dams is statistical significant a statistical method was used. As the presence of small farm dams is always reducing the river flows, in order to test the statistical significativity of the results, a bootstrap approach was used. Such approach allows verifying that the differences between the cases with and without dams are statistical significant compared to a random rearrangement of the distribution obtained with the two cases. To do so, the two samples are rearranged a thousand times with mixed values, and*

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the differences between the two rearranged sets are computed, and their distribution is analysed. The results are statistical significant at the 5 % level if the probability to reach the results in the resulted distribution is lower equal to 5%. The same approach was used to infer the statistical significativity of the results in the context of climate change.

Minor comments

P9, 1st paragraph. This sentence is now rewritten: *However, the characteristics of the existing small farm dams are not well known. An investigation in 1997 reported less than 180 dams larger than 2000* m^3.

In section 3.1, it could have been relevant to include the existing 0.186 % of small dams already existing. My understanding is that they are not included, maybe a word explaining why they have not been added for the evaluation could be added here

It is correct that section 3.1 is devoted to the assessment of the modelling without small farm dams, while section 3.2 is focussing on the impact of the small farm dams in the hydrosystem. Indeed, the assessment is made on a 30 years period, from 1970 to 2000, and the development of the small farm dams during this period is not wellknown. By assuming no dams at all during this period, it is expected to get an overestimation of the flow. Such overestimation is indeed found and discussed in this section.

To make this point clearer, prior section 3.1, the following text was added: *"As the development of these dams along the period 1970 to nowadays is not wellknown, it is chosen to run a simulation without small farm dams, and to compare such simulation with the observations. It is expected that the model will overestimate the observed flow, especially during the filling period. Then, the inclusion of the small farm dams in the model allows to study their impact on the riverflows"*. Then, the text was sligthly modified in section 3.1: *Although it is clear that part of the error is linked to a poor estimation of the parameters describing the basin characteristics and to the physics of*

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the model, part of the error is expected to be linked to the presence of small farm dams. Indeed, between 25 and 50 % of the error can be linked to the water intake (depending on the period of reference for the water uptake).

P12, second paragraph explanation of figure 6. There is a mismatch between the figure with a 0.2 and the text with 20%.

Thanks for noticing this mistake. There was an error in the yaxis caption of Figure 6: the values are not expressed as a percentage, but as a fraction, 0.2 meaning thus 20%. This is now corrected.

p 12,4 second paragraph, for the Seine and maybe Loire basin, the presence of aquifers could be mentioned

Done, it is not stated: *Moreover, in some regions like part of the Seine basin, the Rhine and Rhone alluvial valleys, pumping from regional aquifers might be preferred to small farm dams.*

p15 second paragraph in 5.2 "and they are not affected by the same regulation on the filling period". This is a bit unclear. Is the regulation of farm dams different or the regulation of water more generally (because of hydroelectricity, probably)?"

Yes, hydropower dams are not affected by the same regulations than small farm dams. Indeed, they do not intercept brooks, but rather large rivers. Hydropower dams are usually not constrained by fixed filling period, but they have to assure a miminum riverflow. Therefore, in section 3.2.1 it is now written *"Actually, numerous hydro-power dams exist in these mountainous regions, with quite different filling periods, since the captured flow is provided by snowmelt rivers."*

and in section 5.2 *"However, as stated before, hydro-power dams are present nowadays in these mountainous regions, and they are not affected by the same regulation than the small farm dams, and especially, their filling periods are not fixed."*

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