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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Historical impact of water infrastructure on water levels of the Mekong River and the Tonle Sap System" *by* T. A. Cochrane et al.

Anonymous Referee #2

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This paper intends to assess the effect of recent hydropower dam and irrigation developments on the water levels of the Mekong and Tonle Sap rivers. In addition to the issues raised by the first referee (Ilyas Masih), I have two additional criticisms:

A/ In the context of the Mekong River, water level variations do not necessarily reflect upstream hydrological changes and thus, cannot be used alone to evidence and quantify the magnitude and statistical significance of hydrological changes.

This analysis primarily uses water level data of the Mekong mainstream to investigate hydrological impacts. Using water level instead of discharge data is tempting because water levels records of the Mekong River are of good quality, compared to flow data: daily time series are virtually uninterrupted since automatic water level recording sta-

tions were installed in the early 1960s. In contrast, discharge values are missing for many years at several stations and often include errors which are difficult to detect, quantify and correct. The main source of uncertainty in discharge values originate from the rating curve (stage – discharge relationship) which used to be updated every year at each gauging station to account for possible changes in the river cross section (because of sedimentation and/or erosion). Where the cross section is stable (rocky section), flow time series can be confidently estimated from water levels over multi-year periods using one single rating curve. However, at some gauging stations of the Mekong River, especially in the downstream part of the Basin (e.g. Mukdahan), sandy banks continuously modify the relationship between water levels and discharge. In this situation, flow estimation using outdated rating curves may lead to non-negligible bias. I would therefore recommend the authors to carefully assess possible bias caused by changes in river cross section when attempting to detect hydrological changes using water level data. Slights changes in the river cross section can accentuate or moderated water level variations caused by upstream catchment modifications. One option could consist in comparing the rating curves before and after 1991 at each station. For example, the authors could plot the measured discharges corresponding to each water level (1m, 2m, 3m, etc. . .) against time (i.e. 1 curve per water level), using the rating curve data available in the MRC hydrological year books and maybe in the MRC database. Another informative graphic could include one "average" rating curve (discharge on Y axis and water level on X axis) for the period before 1991 and another for the period after 1991, with the multi-year variability depicted by standard deviations at each plot.

B/ Due to the limited hydrological contribution of the Chi-Mun Basin to the Mekong River, water infrastructure developments in this sub-basin are not likely to have significantly altered the mainstream flow regime.

The authors indicate that hydrological alterations at Pakse can be attributed to water infrastructure development in the Chi-Mun basin, including hydropower and irrigation

development. This explanation is not supported by rigorous scientific demonstration. One impediment to this hypothesis is the relatively low flow contribution of the Chi-Mun Basin to the Mekong River. Using the numbers provided in the manuscript (page 4410, line 24: average annual flow of 32,280 Mm3 in the Chi-Mun Basin; page 4424, Table 1: mean annual flow of 9,700 m3/s in the Mekong River at Pakse), it can be estimated that the relative contribution of the Chi-Mun Basin to the Mekong flow is about 10%. This low percentage indicates that possible hydrological alterations in the Chi-Mun Basin are considerably attenuated downstream of the confluence with the Mekong River. In addition, the reservoirs that were built in the Chi Mun Basin have most likely very little influence on the river flow regime at the basin outlet for two reasons: there are either located in the headwater catchment areas with relatively low drainage areas or have very little active storage capacity: the storage capacity of Pak Mun dam, 225 Mm3, is equivalent to less than 1% of the Chi-Mun basin water yield. Another problem is: page 4410, line 17: “Seventeen out of the 39 dams in the Mekong basin became operational between 2006 and 2010”. This 5-year period is very short compared to the duration of the second tested period of 20 years. The possible effect of irrigation development on the Chi-Mun Basin hydrology should also be assessed with more accuracy. Page 4410, line 27: “the irrigated area is close to 1,266,000 ha with an annual water demand of 8,963 Mm3”. This water demand is equivalent to less than 3% of the Mekong flow at Pakse and not expected to have a significant effect on the Mekong mainstream water levels. However, the authors should verify the figures for the dry season only when the Mekong flow reduces and the irrigation water demand may increase. Page 4415, line 9: “during reservoir flood control operations” this explanation is not ascertained. Need for more references/evidences. Line 18-19 “thus, an increase of this indicator in such a large river is most likely a direct function of reservoir fill and release operations”. This is speculative again.

Minor comments:

Page 4413, Lines 4-6 at the beginning of section 3.5 and lines 17-19 at the beginning

of section 3.6 should be included in the method section, not in the discussion. Page 4414, line 4: “Fig 4” instead of “Fig 5”. Page 4416, line 26: Kummu et al. 2014 is not in the reference list. Page 4424, Table 1: it would be interesting to add in this table the % of area ratio and dry season flow contribution to total flow. Page 4426. It would be clearer to put the values of table 3 in a graph. Page 4430, Fig 3. It would be useful to provide the p-value of the statistical test (that is used to assess the significant of the change between the two periods) for each month of the year. Using the same scale on the Y axis for the 3 graphs would allow an easier comparison of the graphs.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 4403, 2014.