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Interactive comment on “The role of glaciers in stream flow from the Nepal Himalaya” by D. Alford and R. Armstrong

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With their paper, the authors address a highly topical issue that has recently come into vivid public awareness and subject of controversial discussions. Based on very poor data and on awkward misconceptions, wrong numbers have been persistently reported about glaciers and their contribution to river runoff and water availability to societies from the Himalaya mountains. Although studies exist from highly glacierized basins (as correctly mentioned in several previous comments to the discussion paper), larger river basin scale analyses are unsatisfactory. In their TCD paper the authors emphasize the lack of knowledge on one side and how one can still come to reliable first order magnitudes if common sense and basic glaciological and hydrological concepts are used on the other side. The effort is highly welcomed. Yet, the presentation of the

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analyses and results as well as the discussion part need considerable improvement as I will explain in my General Comments as well as in a series of Specific Comments and Technical Corrections.

General Comments: although I enjoyed reading some of the eloquently written portions of the text very much, they are, for the given purpose, quite lengthy and not always appropriate, particularly in the Introduction, the Procedure, and to some extent also in the Discussion Chapters. These chapters (i) extend on issues not really addressed in the analyses (e.g. glacier retreat and respective impacts, seasonal snow cover) and (ii) show a series of repetitions. The first 3 paragraphs of the Procedure chapter would better be parts of the Introduction, but would still remain widely repetitive. I suggest to focus the text to the core targets of the paper only, and to remove most of the general discussions around missing data and the resulting problems for quantifications. I would also suggest avoiding the tone of excusing for not being able to present better results (which may have been necessary in the original report by Alford et al., 2009 to the World Bank). Instead, the simplifications made and the respective meaning for the results reached needs to be clearly addressed with appropriate references to the respective literature (but note that studies from e.g. Himachal Pradesh and Garhwal Himalaya cannot necessarily be adopted for the conditions in Nepal). Once the boundary conditions (data, remoteness, etc.) are set and the weaknesses of the applied method are properly discussed, the TC reader will understand the resulting limitations and simplifications, and will appreciate the results as a valuable first order estimate. The paper will then become considerably shorter. The Abstract should also be 'cleaned' from lengthy portions and should be focused on (i) putting the question, (ii) mentioning the methods used, and (iii) summarizing the main results.

Tables and Figures seem to be in an 'under-construction' state. Most of them need to be reorganised and/or redrawn. Captions are often inconsistent with what is said in the main text, symbols are often different, the style of writing units varies throughout the Tables and Figures. Try to bring all Figures' layout/text/fonts/numbers into the same

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style. Details are given below.

The paper needs a comprehensive revision.

Specific Comments:

p. 470: Line 10 ff: I suggest changing the sentence: 'The objectives of our study have been to develop methods that allow for a first order quantification of the contribution of glaciers to river runoff from the Nepal Himalaya.' Neither the hydrologic regime nor glacier retreat and respective impacts are subject of the paper.

Line 13: is 'disaggregated' really what you mean?

Line 16: 'mesoscale variability' of what? Do you mean climate or glaciers or both?

Lines 16 – 19: the content of this sentence is mentioned in the introductory but it is not subject of the paper. I suggest to remove this sentence.

Line 25: I think you develop methods but not methodologies. This should be changed throughout the paper.

Lines 27 – 28: I suggest rephrasing as follows: 'We estimate the contribution from Nepal Himalaya glaciers to the annual stream flow from Nepal rivers into the Ganges Basin as approximately 4%. Thus, neither timing nor volume of the Ganges steam flow will be affected materially by changing glaciers'. With this suggested rephrasing I try to focus on what is actually the subject of the analyses and results. In a similar way the Introduction, the Procedure, and the Discussion Chapters should be sharpened and should become considerably shorter. I do not give further detailed suggestions on how to re-shape the text.

p. 472: Line 14: don't call this a 'report' since the presented work should have a different character than your original report to the World Bank (make respective rewording also elsewhere in the paper).

p. 473: Line 2: among many different definitions of the 'tropics' there is no one that

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includes the Himalaya Mountains and their foothills. Also arctic is not an appropriate term. I would suggest to write ‘.. from rain forests to ‘arctic’ deserts, ..’ or ‘.. arctic like deserts ..’.

p. 474: Line 6: I suggest writing ‘...can be expected to vary considerably among mountain ranges...’.

Lines 9 – 10: repetitive.

Lines 12 – 17: repetitive.

P 475: Line 10: how much of the total Ganges basin glacier extent is covered by the study sites’ glaciers?

Line 23: do you mean ‘.. under similar large scale atmospheric conditions ...’ ?

P 476: Line 14 – 15: Here, the reader expects more information on how the gradients were estimated or at least an indication that more information will be given later. Maybe you can also add ‘as compiled in Table 1’ to the sentence.

Line 16: do you mean Figure 4?

Line 26 – 27. I think the Figure 5 does not give much information. I suggest to remove it as well as the respective sentence in the text.

p. 478: line 6: repetition from p. 477, line 13

p 477: Chapter 4: Personally, I have objections against using ELA other than in the precisely defined way (the altitude where the vertical mass balance profile crosses the zero value). I leave it to the Editor to ask for changing terminology here.

Equation (1) and further, also Table 3 caption: It is misleading to use indices ‘s’ (summer) and ‘w’ (winter) for ablation and accumulation in monsoon dominated regimes where both accumulation and ablation mainly occur only during summer.

Line 28: it seems to me more appropriate to write ‘... hypsometry for the glaciers in

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the Dudh Kosi basin'.

p 479: Line 1: you here refer to snow and glaciers whereas you do not discuss the role and the contribution from seasonal snow cover elsewhere in the paper. You here probably refer to the snow on glaciers only. Please clarify here and possibly make a statement on why seasonal snow cover is excluded from your analyses.

Line 1 and line 7: say more explicitly why estimates produced by this methodology are maximum values? Among others it is also because runoff measured somewhere downriver is modified and glacier input is taken as such without adding proportionally losses by running downriver. On the other side, the fact that you assume glaciers to be in mass equilibrium excludes possibly higher contribution from glaciers under net mass loss.

Lines 13 and 27: repetitive.

Chapters 5 and first paragraph of Discussion: I basically believe what you say here but you should give the reader some support to understand how you rush from 30 to 2% via 10% to 4 % and how you get from some Nepal sub basins to estimates about the Ganges river flow. It seems to me that the 4% are compared to the '200 000 million m³ for the rivers of Nepal'. Is this correct? If so, make this clearer.

P 480: Lines 24 – 26: give references. Note that there is also literature that says the same for Ganges, Brahmaputra etc. as you state on page 481, line 9.

P 481: Lines 8 – 11: It is correct that this statement has also to be put under question, but you cannot do this on the basis of your analyses. The IPCC statement is related to potential changes of glaciers, seasonal snow cover, and shifts in the rain/snow transition level. Since the last two are not addressed here, the respective critic is not appropriate. You may mention it in the Introduction but make then clear that it will not further be addressed in your paper.

Lines 11 – 15: what is the intent of this statement? It will not cause changes in IPCC

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AR4 anymore and, after the extended discussions among colleagues and in the public, it is unnecessary suggesting this to future AR5 Lead Authors. The main point is to produce scientifically sound papers that can be used appropriately by the next IPCC authors. I suggest removing this sentence since it neither refers to analyses made in your paper nor is a useful objective statement.

(The following comments on Tables and Figures are partially scientific and partially technical which is difficult to distinguish in most cases)

Table 1: Caption and table contain a series of symbols neither introduced nor used in the main text. There is no 'Glacier Q' shown in the table as indicated in the caption. Accordingly remove the last sentence including the reference from the caption. Is Q_b the same as q_b ? Is $MCM = mcm = \text{million cubic meters}$? You here use e.g. Area (Km^2), in the other tables you write Area, km^2 . Please standardize by following TC rules and guidelines.

Table 2: Again new symbol, not introduced or used in the main text (q, m). Reference to Figure 3 should be to Figure 4. The entire Table needs to be reorganised; it seems to repeat the same information in the right half but for another basin; it is difficult to see how the last 3 lines fit into the top table concept ('calc' and 'meas' in the same column as q, m).

Table 3: Avoid using indices 's' and 'w' (see comments made above). Separate the two table halves clearly so that the reader can see that the right one is the continuation of the left half. Remove the Totals line on the left half. Remove the Column1 – Column7. Last line in caption: how do you get a specific winter budget of 2.6 m water in a monsoon climate where winters are pronouncedly dry?

Figure 3: Caption: tell the reader what the numbers indicate. It would be useful to show all gauging stations used.

Figure 4: Remove all shadows from symbols. Use simpler and smaller symbols. To big

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symbols and graphical effects distort the information.

Figure 5: (if it remains, see earlier comment): remove shadows from the bars. Unify fonts and text style. What is Qv in the left panel's legend?

Figure 6: Remove shadow from symbols and use smaller symbols. Remove small scale background grid. Use smaller fonts for text and numbers. Caption: Should it say 'calculated from measured' instead of 'measured'?

Figure 8: Figure title should go into caption. Vertical axis text should be something like 'annual stream flow volume [10^6 m³]'. Caption: first line: 'relative annual stream flow volume in 10^6 m³'. Is it really 'relative'? If so, relative to what?

Technical Corrections:

p. 470: Line 13: 'these glaciers' instead of 'these glacier'

p. 472: Line 16: 'they relate' instead of 'it relates'

P 475: Line 17 and throughout the paper: I suggest using [10^6 m³] instead of million cubic meters, mcm, MCM etc. Yet, it should follow TC customs and guidelines

P 476: Line 1: should it be '..Himalaya Mountains ..' instead of '..Himalaya Mountain ..'?

P 482: Line 23: "Deutsches Nationalkomitee für ..."

Figure 7: text and numbers are too small. Add full stop and space after Duth Kosi glaciers.

Interactive comment on The Cryosphere Discuss., 4, 469, 2010.

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