Dear Dr Weerts,

Thank you for recommending publication, subject to minor revisions, for our manuscript. We have now completed these revisions.

As requested by reviewer 2 we included a comparison with HydroSHEDS. In section 4.4 we compared the length of stream delineated by HydroSHEDS and our national database in a selected river basin (the Macleay River Basin) and noted the additional features our database supplies. We also referred to two new figures that compare the representation of natural drainage density and distributary drainage structures.

We revised the manuscript in response to the comments by reviewer 1 as noted below. A full list of all changes to the manuscript then follows.

Thank you too for the advice about TerraHidro. We were not aware of this development and are interested to learn more about the TerraHidro method.

Kind regards

Janet Stein

Authors response to specific comments from Reviewer #1

RC:Page 15436, line 23 to page 15437, line 1: I find the description of the global databases HYDRO1k and HydroSHEDS to be somewhat misleading. It is true that both databases offer only certain pre-defined stream networks and basin boundaries. But the mentioned limitations, in particular the fact that the available products only include stream delineations for catchments larger than 1000 or 20 square kilometers, respectively, are simply due to arbitrary thresholds that were applied by the producers. It is a rather straight-forward task to extract other stream networks or catchment subdivisions as desired by a user. Furthermore, the HydroSHEDS database offers a seamless drainage direction map, i.e. the basis for stream delineation, at 3 arc-second resolution, not 15 arc-second as mentioned in the manuscript. I suggest that these explanations are clarified accordingly. I believe, however, that this comment does not contradict the authors' general conclusion that the global databases cannot (and are not intended to) achieve the quality of the applied national data for the Australian continent.

AC: We readily acknowledge the great value of the HYDRO1K and HydroSHEDS global databases and the opportunity they provides users to derive a finer resolution stream network. We have clarified and extended the description of the Hydro1K and HydroSHEDS databases as suggested, noting key limitations that prompted the development of a new database for Australia. These include the lack of recognition of anabranching stream systems and the difficulties involved in identifying suitable contributory area thresholds for stream network delineation across a continent with highly variable drainage density.

RC:Pg. 15437, l. 14, and elsewhere: The reference of "Stein and Hutchinson 2014" should really be "Stein and Hutchinson in prep." and should be changed accordingly. Obviously, it is rather unfortunate that this publication describing the applied new methodology is not yet available. The same reference is used in section 3.1, and here the unavailability of the publication is even more critical. From what I understand, the described processes are designed to derive a DEM-based stream network that matches (as good as possible) the stream network of 1:250K maps, and then

these two sets of stream networks are interlinked (via IDs). This is all very interesting, but without the mentioned reference it is somewhat hard to follow or verify. Maybe a few more explanations would be useful here?

AC: We replaced the reference to Stein and Hutchinson (2014) with a statement that notes that the methods employed in this manuscript significantly extend those presented in earlier material that is available online (Stein (2006) and Stein and Hutchinson (2009)) and that a full technical description of these methods is in preparation.

RC:Pg. 15438, l. 3: The authors mention that the automated procedures were combined with manual editing, and in chapter 3.1 they state that corrections were applied "as far as possible" (pg. 15439, l. 19). These diversions from fully automated procedures deserve some special attention as they make the applied methodology difficult to replicate or interpret. Maybe some additional comments can be added in the discussion section? Are manual edits unavoidable?

AC: We added an additional comment to indicate that the drainage analysis procedures are now fully automated and thus more easily replicated.

Line 19 pg 15439 We removed the phrase "as far as possible" so that it does not imply that additional manual edits were applied.

RC:Pg. 15440: The last sentence is not entirely clear to me (semantically).

AC: We reworked this sentence to try to make its meaning clearer, breaking the long sentence into three, the first describing the sub-division of the drainage basin, the second the application of the coding scheme and the third the coding of internally draining basins.

RC:Pg. 15442: This page provides quite detailed regional information and explanations that are very specific for Australia. I believe this level of detail is not necessary to understand the manuscript. Is it possible to condense this section a bit? The same comment goes for pg. 15450.

AC: On page 15442 we made our description of the differences with the AWRC basins more concise and combined two paragraphs into one to reduce the level of detail as requested by Reviewer 1.

We retained the level of detail in the section describing the applications of the database on pg.15450 as we felt it was necessary for a reader to understand the critical role of the database.

RC: Pg. 15443, l. 15-16: The authors use "a modelled estimate of runoff volume rather than contributing area to discriminate the tributary and main stem" in their Pfafstetter coding. They also mention this method ("surrogate of river flow") as an advantage in the discussion section (page 15452, line 29). On the one hand, I agree that this is an elegant solution to avoid that dry rivers with large contributing areas are (incorrectly) coded as the main stem rivers. On the other hand, this method introduces an ambiguous threshold: if the modeled runoff has any errors and requires updates in the future, it would necessitate that the entire Australian stream network is recreated and recoded. Can the authors comment on this problem in the discussion section? Can they also clarify where these runoff estimates are coming from (also in the caption of Figure 7)?

AC: We expanded the discussion to include a comment on the potential disadvantage of this method for discriminating the main stem and tributary. We also included a statement on the origin of the runoff estimates referred to in section 3.2.3 and added a description of the method used to generate the runoff lookup table in section 3.3 that provides the source of the data mapped in Figure 7

RC:Pg. 15444, l. 13: The authors acknowledge that the catchment size within Pfafstetter levels (below level 9) can vary significantly. This may lead to significant inconsistencies in subsequent applications. Can the authors briefly comment on this shortcoming? Do they think it is an intrinsic problem of the Pfafstetter coding that cannot be solved?

AC: We commented on this issue as suggested and indicated how it might be overcome for particular applications requiring more homogenously size catchments.

RC:Pg. 15448, l. 8: I suggest "up- or down-stream" instead of "up or down stream"

AC: Change made

RC:Pg. 15451, Section 4.3 (Limitations and uncertainties): I would expect that the delineation and assignment of inland sinks is highly problematic due to their ephemeral nature and the potential of bifurcations (if flooded, the sinks may overflow in different directions). I understand that there is no real solution to this problem, but can the authors mention this issue as another source of uncertainty?

AC: We commented on additional sources of uncertainty including that due to the reliance on the ANUDEM diagnostics to locate inland sinks rather than employing a comprehensive search and that surrounding the location of the sub-catchment boundaries of individual stream links within the more dynamic braided and anastomosed channel networks. We also noted that the elevation difference between alternate pour-points may be small in some cases and thus there is additional uncertainty as to which neighbouring basin a sink basin would overflow.

RC: Pg. 15452, l.1-11: I am not sure I understand this argument correctly. Even if streams are burned into the DEMs of the US and European databases, this does not prevent the calculation of topographic descriptors from the original DEMs (i.e. before burning).So I do not really see an important difference or advantage here.

AC: We explained this issue more fully to clarify its meaning.

List of manuscript changes

Note that line numbers refer to line numbers in the HESSD document (hessd-10-15433-2013.pdf). Simple changes to the text were made to the downloaded latex version of the manuscript (hess-2013-487-discussions-typeset_source-version4.tex). However, the additional references and figures listed below will need to be inserted with appropriate formatting commands.

Changes to the manuscript text

Pg.15434,Line 5 –Replaced "there were…" with "there have been…"

Pg. 15434, Line 11- Added a comma after "pathways"

Pg. 15434, Line 12- Deleted "across"

Pg. 15435, Line 4 – insert ed "also" before "provides unambiguous evidence…"

Pg. 15435,Line 11 – deleted "also"

Pg. 15436, Line 9 – replaced “are” with “were”

Pg. 15436, Line 25 – included “and the most accurate” after “The most recent…”

Pg. 15436, Line 26 – Included “, http://www.hydrosheds.org/” in the citation for HydroSHEDS

Pg. 15436, Line 29 –pg.15437,Line 1 –Replaced “a contributing area of less than….” With “contributing areas less than …”

pg.15437,Line 1 – Inserted 2 new sentences after “respectively.”: “HydroSHEDS also offers a seamless flow direction grid at 3 arc-second resolution to enable users to apply a lower contributing area threshold and thus delineate smaller streams. However.....”

pg.15437,Line 1 – Replaced “these databases” with “the global databases”

pg.15437,Lines 14-15– Deleted citations “(Stein and Hutchinson, 2014; Stein 2006)”

pg.15437,Line 17– Inserted new sentence after ”.....Australian continent.” : “They significantly extend those presented in earlier material (Stein, 2006; Stein and Hutchinson, 2009) and will be described fully in a forthcoming manuscript.”

Pg. 15438, Line 6 – Inserted 2 new sentences after ‘...channel network.” : “. More recently, these procedures have been fully automated so that the task of removing such anomalies in the flow direction grid is more easily replicated. Improvements in the ANUDEM.....”

Pg. 15439, Line 1 – Deleted citation “(Stein and Hutchinson, 2014)”

Pg. 165439, line 7 - Replaced text “….were removed while retaining main stem segments, being the segments draining the larger upstream contributing area, to their source” with “were removed while main stem segments draining larger upstream contributing areas were retained to their source”

Pg. 15439, Line 19 – Deleted “as far as possible”

Pg.15440, Lines 3-4- Replaced “while removing some of the discrepancies…” with “without the discrepancies …”

Pg. 15440, Line 12 -Deleted “(about 270m)”

Pg. 15440, Line 22 -Deleted “globally”

Pg. 15440, Lines 23-28 – Reworked the sentence into 3 sentences that now read: “The Pfafstetter scheme uses the topology of the stream network and the size of the drainage area to guide the sub-division of drainage basins into successively smaller catchment units that are coded with the digits zero to nine sequentially from the outlet of the catchment unit upstream to its source. Thus, the four largest tributary catchments are coded with the even digits 2 to 8 while the five inter-catchment units are assigned the odd digits between 1 and 9. A single closed (internal draining) basin, that being the largest in area within the larger, higher level catchment unit, is assigned a Pfafstetter code of zero.”

Pg.15441,Line 3 – Inserted “each” before “inland sink”

Pg. 15441, Line 7 – Deleted “so”

Pg. 15442, Line 10- Moved “(1977)’ after van de Graaff –

Pg. 15442, Lines 14-28 –Re-drafted and combined two paragraphs into one

Pg. 15443, Line 5 - Replaced “occupies” with “occupied”

Pg. 15443, Line 11 - Deleted “(Stein, 2013)’

Pg. 15443, Line 16 – Inserted text “Runoff volume was calculated by summing the upstream values of the annual time series of runoff estimates (1900 to 2007) produced by the Australian Water Availability Project (Raupach et al.,2009; 2012)”

Pg. 15446, Line 15 – Insert new paragraph “The summary statistics derived from the monthly time series of runoff are .....”

Pg. 15446, Line 16 Inserted text “directly from the database” after “derive”

Pg. 15447, Line 1 – Replaced text “It delineates streams and their catchments continent-wide,...” with “Its continent-wide delineation of streams and their catchmentsis ....”

Pg. 15447, Line 13 – Moved “(1977)” after van de Graaff

Pg. 15447, line 15 – removed ‘a”

Pg. 15447, Line 15– made ‘section” plural, deleted “respectively,”

Pg. 15447, Line 16 – Inserted “respectively” after “Great Australian Bight”

Pg. 15447, Line 22 – Deleted “so”

Pg. 15447, Line 23 – Inserted comma after “drainage structures”

Pg. 15448, Line 12 – Inserted 2 sentences: “The size of the catchment unit at each level in the nested hierarchy varies substantially, largely as a consequence of the natural variation in drainage density and basin size that occurs at continental scale. Nevertheless, ...”

Pg. 15448, line 22 – Inserted new paragraph “ We have modified ...”

Pg. 15450, Line 23 – Replaced “In” with “in”

Pg. 15450, Line 28 – Replaced “user’s needs” with “user needs”

Pg. 15451, Line 10 – Inserted after (Craddock et al. 2010) new sentence: “The sinks that are the .....”

Pg. 15451, Line 11- After “DEM” inserted text “and the reliance on the ANUDEM diagnostics, rather than a thorough search, to identify sinks “

Pg. 15451, Line 21 – Inserted after “channel.” new sentence “There will also be....”

Pg. 15451, Line 25 – Inserted “and global” after “national”

Pg. 15452, Line 3 – Inserted text “or that underpinning the HydroSHEDS global database (Lehner et al. 2008)” after “DEMs”

Pg. 15452, Line 4 – Inserted new sentence after “DEM.” : “These processes significantly alter.....”

Pg. 15452, Lines 12-21 Replaced paragraph with 3 new paragraphs beginning “The new Australian database ....” and “The national framework presented here...” and “Our framework ....” respectively

Pg. 15453, Line 21 – Inserted text “1:100,000 scale” before “contour”

Pg. 1545, Line 21 (Acknowledgements) Inserted text “and incorporates data that is © Commonwealth of Australia (Bureau of Meteorology) 2012.” After “ANU”

Pg. 15460, lines 26-27 – deleted reference Stein, J.L. 2013

Pg. 15460, lines 32-33 – deleted reference Stein and Hutchinson 2014

Pg. 15474 Figure 7 caption Added sentence: “Data extracted from the runoff lookup table (see Table 3).”

Figure 7 – A new image file will be supplied which includes mapping of additional streams in central Australia that were erroneously omitted from the previously supplied version of this figure

Captions for new figures 8 and 9

Figure 8. The stream network delineated by (a) this study and (b) that supplied by the HydroSHEDS database (Lehner et al. 2008). Level 1 drainage divisions are indicated by the bold black lines.

Figure 9. The stream network and drainage basins delineated by (a) this study and (b) supplied by the HydroSHEDS database for the area shown in the inset map of Figure 4. By recognizing distributary drainage connections one drainage basin is delineated for these rivers draining into the Gulf of Carpentaria while the HydroSHEDS database delineates multiple basins.

New references (to be inserted into reference list)

Australian Bureau of Statistics: Official Year Book of Australia No. 60, 1974, Australian Bureau of Statistics, Canberra, 1974.

Lehner, B., and Grill, G.: Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems, Hydrological Processes, 27, 2171-2186, 10.1002/hyp.9740, 2013.

Raupach, M. R., Briggs, P. R., Haverd, V., King, E. A., Paget, M., and Trudinger, C. M.: Australian Water Availability Project , CSIRO Marine and Atmospheric Research,: http://www.csiro.au/awap, last access: 25 March, 2014.

Raupach MR, PR Briggs, V Haverd, EA King, M Paget, CM Trudinger ,Australian Water Availability Project (AWAP): CSIRO Marine and Atmospheric Research Component: Final Report for Phase 3. CAWCR Technical Report No. 013. 67 pp., 2009