

Interactive comment on “Global hydrobelts: improved reporting scale for water-related issues?” by M. Meybeck et al.

M. Meybeck et al.

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We appreciate a lot the careful work of the anonymous reviewer #2 and her/his thoughtful comments on the manuscript. The manuscript has been revised following the comments and suggestions, as detailed below. We believe that these revisions have led to a significant improvement of our manuscript.

REVIEWER #2: The authors propose a division of global landmasses into several hydrobelts – regions characterized by relatively uniform internal hydrological and climatic characteristics and essential differences from each other. They suggest that the resulting geographic division should be used as the basis for reporting hydrological data instead of the currently applied political (based on countries' borders) or continental

C5216

(based on continents' borders) or other types of divisions. It is crucially important to have an objective physically justified basis for geographic analysis of hydrological data and I very much welcome publication of these results. I have a few comments that the authors might wish to take into account in the final HESS version of their study.

RESPONSE: We thank you for this comment.

We have somewhat simplified our outline now in the revised manuscript. The application to the population distribution is now revised and presented at the end of the paper, under Discussion –including a new detailed discussion of the population over runoff ratio, used as a potential pressure indicator. At the end of revised discussion the representation of population in the T° vs q domain for different political entities vs hydrobelts, hydroregions and coastal catchments. The results (figures and tables) are not modified but the text has been revised and somewhat simplified, and the structure is modified.

REVIEWER #2: 1. The main condition for hydrobelts delineation (p. 9124) is that individual river basins may not be cut between two different hydrobelts. Suppose we have a number of river basins covering the entire landmass of the Earth. The task performed by Meybeck et al. consisted in combining the adjacent basins together in such a manner that the resulting variability of annual temperature and runoff within the resulting groupings, Fig. 1, is minimized, while the difference between groupings is maximized.

It would be good to have a discussion of some quantitative indicators of minimizing the internal differences and maximizing the external ones. This would help to quantify the degree of subjectivity involved in defining the hydrobelts. For example, if a different set of researchers independently decided to define hydrobelts according to the qualitative criteria of Meybeck et al. (p. 9124), would they with a 100% probability end in the same division? If not, to what extent and in which aspects their division could differ from that of the present authors?

C5217

For example, the authors mention that in some cases the attribution of particular river basins to one or another hydrobelt was a subtle procedure (p. 9136, lines 5-10; p. 9141, lines 15-20). Perhaps it is here that the discussion could be extended to explain which quantitative criteria were used to reach one or another decision.

RESPONSE: Although hydrobelt delineation is also designed to minimize their intra-belt hydroclimate heterogeneity and to maximise their inter-belt discrepancy, this optimization was not conducted automatically, by using for example clustering, but on the basis of previous studies of river basins at a global scale. We agree thus that our delineation is somewhat subjective. However, we listed our criteria to be clear how the delineation was conducted.

We slightly revised our set of criteria and moved the aim for 'minimising their intra-belt hydroclimate heterogeneity and to maximising their inter-belt discrepancy' to be as a target rather than criteria.

We have now highlighted in the results and discussion sections those basins that are sensitive to hydrobelt delineation in terms of subjectivity. We estimated that the degree of subjectivity is a concern in four areas totalling about 6 M km². This delineation sensitivity is now discussed more in the revised MS after the presentation of hydrobelt as follows:

"Delineation sensitivity

One target of the delineation was to minimise the intra-belt hydroclimate heterogeneity on the basis of temperature and runoff, and to maximize the inter-belt discrepancy. Some regions and/or basins have been on the edge of our attribution, either due to their natural heterogeneity (see further) or due to their situation in-between belts. Also, we aimed at a minimum size of hydroregions and certain north-south symmetry, and balanced distribution of belts in the continents. The most sensitive areas in our delineation were as follow: - The Huang He (Yellow River; part of NML belt), which could also be part of the North Dry belt due to its low runoff. As an exorheic river we considered it,

C5218

however, to be closer to the Yangtze than to the Tarim or Kerulen basins. -The large Himalayan rivers, from Indus to Mekong, were also very difficult to attribute due to the natural heterogeneity of the basins. These basins extend from the polar climates to the dry climates (Indus basin; COSCAT #1336) or wet tropics (Ganges-Brahmaputra basin; COSCAT #1332). After a detailed hydroclimate analysis, we considered both entities to be closer to the Northern Mid-Latitude belt, while we attributed the Irrawaddy-Salween basins (COSCAT #1331) and the Mekong-Chao Phraya (COSCAT #1325), with less extended upper valleys, to the Subtropics. - The Ethiopian Plateau was also difficult to split. The unity of the Nile basin was kept and the other basins (Awash, Omo) were attributed to the N. Dry belt. - The South Mid Latitude hydroregions are not well defined: they are fragmented in South America, limited to a small fringe in Africa, heterogeneous in Australia where the Murray- Darling river, a typical allogenic river with low runoff (less than 7 mm/y), is mixed with much wetter New Zealand basins. The eastern tip of the Southern Africa (0.4 M km²) was attributed here to Southern Mid Latitude belt, despite its relatively low runoff and high temperature (Fig. 4; Table 4), based on its river runoff regimes and to keep a balance between the continents. With this aggregation we wanted to separate it from the rest of Southern Africa that is much drier and less populated. However, this hydroregion is clearly an outlier when compared to the other Mid Latitude regions (see Sect. 4.3; Fig. 6).

Considering our constraints and objectives, it can be estimated that such delicate allocations to a given belt correspond to about 6 M km² out of 131 M km² of non-glaciated areas. Different aggregation would thus not much affect the hydrobelt characteristics but could matter at the hydroregion scale, particularly in Southern Asia, Australia and Southern Africa."

REVIEWER #2: 2. I agree with the suggestion of Dr. Roderick that it would be very instructive to have a table with per capita water availability across the hydrobelts and hydroregions.

RESPONSE: We do agree that it would be highly interesting to work in this direction.

C5219

This will be our next target in the following paper. To follow your and reviewer #1 suggestion, however, we have now considered the water-population relation and its global distribution through a new indicator: the potential pressure indicator. Indicator is normalised to the minimum pressure we found (in North America Boreal region). This indicator is calculated as follows: $(\text{dpop}/q)_{\text{hydroregion}} / (\text{dpop}/q)_{\text{N.Am Boreal}}$. It is dimensionless and varies from 1.0 to about 300. The population pressure on river basin is now discussed by hydroregions under Discussion section.

REVIEWER #2: 3. Since COSCAT as a term was defined in previous papers but is referred to several times through the text and in the Appendix, it would be good to explain this term in somewhat greater detail.

RESPONSE: We agree that a detail description was missing. This is now added to the revised MS as follows

"COSCATs (median size of 0.45 Mkm²) were originally designed to harmonise the reporting of river fluxes with oceans at a global scale (Meybeck et al., 2006). They are continuous spatial entities delineated by river boundaries at the 30' resolution. They originally were defined in two steps. First two extreme coastal cells used as boundaries were determined with multiple criteria as ocean floor topography, regional sea basin limits, continental limits, and minimum coastal runoff gradient. Then the COSCAT basin delineation is realised upland from the two extreme cells on the basis of the upstream river network (see detailed presentation of COSCATs in Supplementary)."

REVIEWER #2: p. 9137, line 19: it is needed to insert LESS and close the brackets: (maximum to minimum monthly discharge ratio LESS than three for the Amazon and less than two for the Congo, having the steadiest river regime)

RESPONSE: Thank you for the comment; this is corrected in the revised manuscript.

REVIEWER #2: Fig. 6: units of runoff should be mm/year

RESPONSE: Yes, this is right. This is now corrected in the revised figure.

C5220