Hydrology and
Earth System
Sciences

Discussions

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Interactive comment on "Global scale human pressure evolution imprints on sustainability of river systems" *by* Serena Ceola et al.

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This paper presents an interesting and novel analysis of how human pressures on river systems have evolved over the period 1992-2013 for over 2000 rivers globally. The paper introduces the metric "Differential Human Pressure on Rivers" to quantify human pressures on rivers. The paper defines Human pressure on rivers as the ratio between the cumulative human presence and activity across the contributing area (here: sum of nightlights) and the natural discharge generated within the same contributing area. Applying this metric to river flow and nightlight data indicates that, on average, human pressure has slightly increased on river systems (+1.6% per year over the 1992-2013 period). These results also indicate hotspots of change (e.g. northern tropical and equatorial areas). The paper states this offers guidance on where the development

and implementation of mitigation strategies and plans are most needed.

This paper addresses a relevant topic and therefore is potentially very suitable for publication in HESS. The results that are presented are interesting. Overall the paper is relatively clearly written and I enjoyed reading it. However, before I can recommend publication of this work, several things need to be clarified.

Why normalize by river discharge? It seems that changes in pressure on river systems (DHPR) are mathematically independent of a location's discharge (since DHPR looks at relative changes and runoff is assumed constant per location). Thus, the "Differential Human Pressure on Rivers" solely quantifies changes in nightlight data along a river network. This is not wrong, but this does not match the description that is used throughout the paper.

To what extent is nightlight data representative for human pressure on rivers? I understand that nightlight data is actually a useful proxy for "human presence and activity" but whether it is a good proxy for human pressure ON RIVER SYSTEMS is never shown. Sure, we expect that places with no nightlight tend to have very little human pressures on the river system, and that places with a lot of nightlight data, potentially have a great influence on river systems. However, many aspects that most greatly pressure river systems (e.g. irrigation, dams, etc.) are probably not necessarily very correlated with nighttime data?. I do not say this because I think nighttime data is not useful, I just think it would be very helpful to make clearer/discuss to what extent nighttime data represents actual pressures ON THE RIVER SYSTEMS.

To what extent are changes in time in nightlight data representative for changes in time? The validation of DHPR is done on a spatial comparison with previously used metrics. What makes you confident that the metric can meaningfully quantify changes in time in human pressure (rather than characterize differences in space)?

What makes a hotspot a hotspot Hotspots can be identified based on absolute pressure, or changes in pressure. The focus in this paper seems on the latter. However,

these are all "relative changes" in pressure, but is a relative change really relevant when the "absolute pressure" is very low"?

To what extent do the results say anything about human security and sustainable development Result are often put in these big terms. For example "Our study identifies critical zones where the change rate of human pressure will undermine human security and sustainable development in the near future." This statement seems unfounded and a strong overinterpretation of the results. Undermine human security? Sure, this may be related to your index, but that cannot be seen from any of the results that you have (any linkage there is purely speculative and not scientifically shown by your work). I would suggest to tone down the interpretation a bit, and more focus on the facts that you actually show

Detailed comments below Note that, at times, "buzzwords" with an unclear/unspecific meaning are used which makes it for me difficult to follow at times) I made some suggestions in the detailed comments below, but this is not necessarily exhaustive. I would encourage using clearly defined terms throughout the paper.

I think all these issues can be addressed with textual changes, and I look forward to seeing a final version being published soon in HESS.

Detailed comments

Throughout the entire paper: "Vorosmarty" should be "Vörösmarty".

Page 1

L2: The part "with severe implications for anthropogenic activities and river ecosystems" seems redundant and makes the sentence slightly awkward to read.

L3: "was already exposed" instead of "was exposed [...] already".

L4: can you be more specific than "these threats (to water security)"? If no, that's ok. If yes, that would be helpful. That water security is becoming an increasingly relevant

topic is namely not new. Quantifying its changes is.

L5: I would suggest to remove "simple, objective and effective". All these qualifications are arbitrary, and I would let the reader decide to what extent this is the case.

L6: "to quantify" instead of "to measure".

L7: normalized human pressures "on river systems" (considering adding the last past for clarity).

L8: "time invariant discharge data" sounds odd. The data itself is not time invariant, which this wording suggests (to me). Maybe use "time-averaged" which is nearly the same but seems to be a better fit (to me).

L9-11: This sentence reads a bit odd. Consider "The results show that normalized annual human pressure on river systems increased globally, as indicated by an average DHPR value of 1.9% per year, whereby the greatest increases occurred in the northern tropical and equatorial areas."

L10: It seems to me the units of change (DHPR) are % per year, not %?

L12: "the development and implementation of mitigation strategies and plans" is very unclear to me. I guess that's ok, but if you can be more precise that would be helpful.

L15: Consider something like "have been extensively reported" instead of "than have been well established". OK, maybe my suggestion is not great either, but "established" seems to be an odd verb to use here.

L16: "Increasing" instead of "Enhancing".

L21-22: Consider "how human pressure on river systems can be sustainable in the long term" instead of "if human pressure on river systems is going to be sustainable in the long term."

Page 2

L2: Consider "be assessed" instead of "be then inspected"

L3-4: "in sensitive areas" seems to be redundant/or unnecessarily specific?

L13: "this analysis" or "such analyses"?

L14: "allow" or "provide"?

L14-15: "for the analysis and identification of the main drivers of human pressure on river systems" or "to analyze and identify human pressures on river systems"

L19: Consider being explicit that you propose "A simple and effective methodology" (rather than "is proposed" which makes it unclear who has done this).

L23-24: "which epitomize surface hydrological processes within a river basin and represent the river natural flow regime" seems redundant (first part) and not necessarily accurate (second part), so I would suggest to remove it.

Page 3

L6: "concluding" instead of "conclusive".

L9-11: "The Simulated Topological Network STN-30 (Vorosmarty et al., 2000a, b; Fekete et al., 2001) was the digital river network used in this work."

Page 4

L3: "which overcomes" instead of "which overcome"

L25-28: "The computational steps explicitly incorporate catchment topology and use a routing scheme based on flow directions to evaluate the downstream accumulation of human presence and activity and natural river discharge" It seems that in the end the method does not incorporate river discharge?

Page 5

L13: Can you explain why "Standardization was essential to test the reliability of the

proposed methodology."?

L22: "clearly" seems redundant (and arbitrary).

L24: the unit is % per year? not %?

Page 6

Line 24: "Student's T-test" or "Student's t-test"?

Section 2.4: Can you comment on why a significant correlation in SPACE between this variable and previous metrics warrants the use of DPHR (which quantifies changes in TIME)?

Page 7

L5: what do you mean by "and then consolidated by region", do you mean "grouped by region"?

L9: "extent", not "extension"?

L33: I do not know why does would "clearly imply severe endangerment levels" (beyond a reader's own interpretation)? what does "severe endangerment levels" actually mean here?

Page 8

L2: "human footprint focuses on the entire terrestrial realm and does not explicitly consider river systems" can you be more precise/specific here? I do not know what this means.

L6: what do you mean by "recent outcomes on the terrestrial realm"?

L7: Be explicit that you now talk about hot spot regions OF CHANGE.

L8-9: "at an accelerated pace" seems redundant (and is something that is not looked at in this paper), therefore I suggest to delete it.

L11: units are % per year?

L32-33: "DHPR identifies critical zones where increasing trends in human pressure on river systems will undermine human security and sustainable development in the near future." This seems like a strong overstatement to me (i.e. how do we know these areas will "undermine human security and sustainable development in the near future"?). I would really recommend toning down this statement.

L33-34: "River basins located within the northern subtropical and equatorial belts across Africa and Asia clearly epitomize this situation, showing markedly positive change rates in the 1992 to 2013 period". Making a statement on strong positive DHPRs in these regions is fine. I believe you cannot say (from your results) that these numbers simply show "critical zones where increasing trends in human pressure on river systems will undermine human security and sustainable development in the near future".

Page 9

L8-9: what do you mean by "global sustainability levels of river systems"?

L11: "in the near future" seems redundant and overly restrictive.

L12: "objective and powerful" seem both to be subjective and redundant. Personally, I would let the reader conclude this, rather than make this conclusion for them.

L11-13: "The Differential Human [...] needs to be taken" is not a logical sentence. Please rephrase.

L13: "identifies areas where priority action needs to be taken" should be removed.

L17: Nightlights and river discharges are [considered] the sole controlling drivers of human pressure on river systems. (add the word considered).

L18: "have been proven", not "have been proved".

C7

L17-26: I appreciate that these limitations are discussed. However, I think it is much more relevant to point out the limitation that nightlight data can have very little to do with human pressure on rivers, and is a largely unvalidated proxy for this.

L24: these action wont "cast some doubts on nightlight values", they will "cast some doubts on to what extent nightlight values represent the changes you are interested in here".

L32: The following statement seems at odd with a study that focusses on human pressure on rivers "Furthermore, given that our focus is on natural river systems, [...]"

Page 10

L10: I am unsure what "an order zero information" means

L12-13: "Our study identifies critical zones where the change rate of human pressure will undermine human security and sustainable development in the near future." This statement is unfounded and seems like an overinterpretation of the results. Undermine human security? Sure, your results can be related to limited water resources, but your statement is not shown by any of the results that you have.

Page 13

Vorosmarty" should be "Vörösmarty

Page 15

In the figure, F overline should be in italics?

Page 16

Figure 3: In the titles of the subpanels: DHPR should be in units % per yr?

C8