Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2017-474-AC2, 2017

Hydrology and Earth System Sciences Discussions

Interactive comment on "Modelling freshwater quality scenarios with ecosystem-based adaptation in the headwaters of the Cantareira system, Brazil" *by* Denise Taffarello et al.

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Received and published: 4 December 2017

Responses to Reviewer Comments # 2 (RC2):

RC2 – "The hypothesis of the research is not clear, and is it "the conversation practices impact hydrological services?" Answer: The authors would like to thank the comments from Reviewer 2 and welcome them. The hypothesis of the paper is related to how conservation practices addressed by EbA impact hydrology and the ecosystem services, such as maintaining, restoring or improving both the water yield and the freshwater quality, using ecohydrological modeling in different catchment scales. On the other hand, we hypothesized that incentives of EbA policies can affect water yield and wa-

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ter quality through non-linear tradeoffs, with high spatiotemporal complexity, which can be assessed by modeling, but previously supported by in-situ monitoring variables for setup boundary conditions of simulation runs. We enhanced these staments in the updated version of the manuscript, refining the statement written previously in lines 87 to 91.

RC2 - What is the EbA, and the authors should give the readers more detailed deïňĄnition. Anwer: The concept of Ecosystem-based Adaptation (EbA) is addressed as 'using biodiversity and ecosystem services to help people adapt to the adverse effects of climate change', which was deïňĄned by the Convention on Biological Diversity – 10th Conference of the Parties (CoP) (CBD, 2010, quoted). The payment for ecosystem services is known as a method of EbA. Detailed definitions of EbA applied to the Cantareira's Headwaters (the study area of this manuscript) can be found in our most recent article: Taffarello et al., 2017 [Climate Services (2017), http://dx.doi.org/10.1016/j.cliser.2017.10.005].

RC2 - In addition, the paper is so long, and the authors should condense the whole text, as well as the ïňĄgures and tables. Answer: Regarding this specific comment, a new, updated version was written, moving some tables and figures to the Supplementary Material. With these actions, the new manuscript has decreased the number of words and graphical elements, but maintained only essential statements and new answers for specific revisions.

RC2 - The authors considered the land use scenarios only, but not the climate hydrological factors. Answer: Due to the high complexity of the interaction and coupling drivers of the climate-soil-water-human nexus, the main objective of the paper aims to only test hypothesess of changes in land use, with adaptation measures PES-Water from EbA options policies. Climate change scenarios will be included in a forthcoming paper. This subject is not relevant to this paper. Some evidence of climate change in hydrological factors, including sensitivity analysis of water withdrawal scenarios, and economic indicators in the Cantareira System's catchments throughout 2000-2100 scenarios can be found in Mohor & Mendiondo (2017; 10.1016/j.ecolecon.2017.04.014, quoted).

RC2 - The authors should explain the reason why nitrate, TP, and sediments have been select to assess greyWF. Answer: SWAT model outputs perform different water quality variables (see Arnold et al, 2005; Bressiani, 2016; quoted). Here we chose to evaluate the greyWF through modeling because these are some freshwater quality variables we had previously sampled in experiments, since such variables are useful for proper SWAT parameterization (see Taffarello et al, 2016-a; quoted). Using a higher number of freshwater variables, however, can make the modelling evidence (on hypothesis testing with EbA) either over-parameterised for analytical purposes or even excessively-detailed for current Brazilian standards of freshwater classificationâĂŤi.e. with some outputs of freshwater quality variable 1 being above the standards, with variable 2 being below the standards, making it harder for decision-making and planning). Moreover, the high uncertainty in hydrological responses of pollutant loads observed in nested catchment experiments under land change in Brazilian biomes (see Zaffani, A G, Cruz N, Taffarello, D, Mendiondo, E M (2015), Uncertainties in the Generation of Pollutant Loads using Brazilian Nested Catchment Experiments under Change of Land Use & Land Cover. J. Phys Chem Biophys, doi: 2015.10.4172/2161-0398.1000e123; now quoted in the references of the updated version) recommend more parsimonious monitoring and modeling tests to study potential tradeoffs with conservation practices and economic incentives such as EbA.

Page 11, Lines 295-297: RC2 - “WPL[x,t] exceeds 100%, environmental standards are violated...”, it is so subjective. What’s your basis?. Answer: We appreciate this comment. Following several authors (see Hoekstra et al, 2011; quoted), there is not an upper limit for GWF; it depends on the level of polluted loads being transported into the streamflow. These loads originate from coupling the natural and antropic hydrosedimentological cycles, from the headwaters to the outlet of the basin. Alloctonous and autoctonous loads transported in the main flow, either during floods or even during low-flows, as during the annual flow regime, represent the pollution demand (the numerator of Equation 1, line 298). Otherwise, the dillution capacity of the river flow is represented by the annual flow regime, i.e. related to the mean water yield (the denominator of Equation 1). Due to this, demand can potentially grow beyond the capacity, “violating” the real dillution capacity or autodepuration of a rivercourse. Another water security index relating this river demand-and-capacity can be found in studies carried out by Rodrigues et al [2014; 2015; also quoted]. Because the pollution load thresholds are being monitored not for a unique, isolated quality variable, but for many of them, also with different thresholds of Brazilian standards, Equation 1 needs further development to represent a weighted-threshold, or composite-threshold, to discuss EbA policies through hydrological modeling and scenarios.

Lines 321, RC2- in equation (3), maybe, it is a mistake about the “WPL[x,t]”, is it “WPLreference”. Answer: We appreciate the reviewer’s comment. According to Equation 3, using a regional basis of intercatchment comparison with a proper non-dimensionality, WPL[x,t] represents the composite threshold of any catchment studied, and regionally compared with the reference catchment (WPLcomposite,ref , in relative terms as in percentage). By doing so, Equation 3 can express how the HSI (hydrologic system index), alternatively and regionally, would point out more healthy catchments (HSI < 100%, where EbA outputs through hydrological modeling are more evident), and other catchments where insufficient EbA effects arise. This approach could help decision-making processes concerning Brazilian freshwater standards [see i.e. http://www.mma.gov.br/port/conama/], where multi-parameterization or variables are combined for testing scenarios of land-use and planning. These standards are also compared with state standards and local agencies, such as CETESB [www.cetesb.sp.gov.br] and DAEE [http://www.daee.sp.gov.br/] in São Paulo and IGAM [http://igam.mg.gov.br/] in Minas Gerais; the two neighbor states share these Cantareira System catchments. Furthermore, and because all these agencies use indices for freshwater health, HSI might help to identify regional intercomparisons, both from monitoring and from modelling scenarios, concerning WPLreference and EbA

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policies.

RC2 - The authors should separate the results and discussion. Some sentences, for example lines 343-345;349-354;357-360; and so on, should be put into Discussion. The independent discussion could further clearly tell the readers your ïňĄnding. Answer: We appreciate this comment. We rewrote these lines to help the reader understand our findings, but we were careful not to exceed the maximum number of words in the manuscript.

RC2 - in Section 3.6, the authors do not depict the results from Figure 17. Answer: We appreciate this review. In Section 3.6, we added extra statements about the comparative results of Figure 17 in the new version of the paper as follows [because of the extension of these new statements, we suggest including them in a Supplementary Material section, according to the Editor′s final decision). “Figure 17 depicts a summary of monitored and modelled water yield observations and scenarios compared with EbA and GWF outputs in the catchments studied in the Cantareira System. The main bold, vertical, dotted line represents the regional mean water yield, compared with water yields from simulated scenarios, also including their respective GWFs. This figure clearly points out six different conditions, labelled with letters (A, B, C, D, E and F), which configurate potential scenarios of water security according to land-use change and insecurity thresholds, also showing tradeoffs between the water yield and grey water footprint outputs, explained in the text.

RC2 - Delete the references from the conclusions. Answer: Thank you for ths observation. We corrected the conclusions, without citing any references.

RC2 - Table 1 should be moved to Supplemental information, or part of Table 1 should be merged in to Table 2. Answer: We appreciate this comment. We corrected this and accepted these suggestions, merging and relocating the tables.

RC2 - Table 8 should be moved in to Supplemental information. Answer: There is no Table 8. Maybe Table 4(?). We moved it to the Supplementary Material. Thank you.

RC2 - Fig.4, explain the meaning of the lines in the ïňĄgure. Answer: Dotted lines represent trend lines for some selected basins illustrated here. Our interest in this figure was to question whether there would be both regional trends or scaling in the calibration coefficients, but not found in this first paper. Regional trends of the calibration can show both limits and uncertainty of modelling complex catchments. Due to space, we decided to omit this figure from the updated version. Fig.5, RC2 - he sentence “Time (horizontal axis) is represented by month/year” is meaningless; further, to provide the meaning of the uncertaintybars andsample numbers. Answer: We appreciate this comment. We corrected the quotation. The uncertainty bars represent the minimum and maximum values of measured streamflow and pollutant loads in a cross section of the river during a field campaign of headwater catchments. The high variance in observations of field evidence explains the greater variability of these headwaters in the Cantareira System Fig.6, RC2 – what are the meaning of the “size of circles” and the numbers? Answer: It is only a representation of a 3-D graph, substituting the 3rd axis with the diameter of the circle proportional to the magnitude of the 3rd variable (in this case, the 3rd variable is the turbidity). The number shows the value of turbidity. Figure 6 shows that, although there was a coherent and proportional relation between the observed mean river velocity and observed specific flow, experimental evidence still depicted outliers, from not only reference catchments with EbA/PES-Water options, but also intervention catchments with no EbA/PES-Water options, reflecting an illustrative example of how complex LULC options from EbA could be exaustively sensed into hydrological parameters and simulated scenarios. For these reasons, we adapted our conclusion and recommendations for further studies about new hypothesis testing, according to the aforementioned answers to the reviewers.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2017-474/hess-2017-474-AC2-supplement.pdf

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