

Interactive comment on “Large-scale lysimeter site St. Arnold, Germany: analysis of 40 years of precipitation, leachate and evapotranspiration” by N. Harsch et al.

N. Harsch et al.

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Final Response to Interactive Comments on HESSD-2008-0099

The authors want to thank all reviewers for their time and effort with this manuscript. Their critical comments significantly helped for its improvement. Thank you again.

Referee 1:

- Comment: "The methods and the results section of the manuscript are not clearly separated." (also cp. Referees 2 and 4) - Response: Revising the manuscript, the authors came to agree with the referees comments on this point. Therefore, the structure

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of both sections has now been revised and improved.

- Comment: "For some parameters the major outcome could maybe also be presented in combined figures." (also cp. Referee 4) - Response: The authors admit that it might be more logical and handy to combine figures 1-3, 4-5, 6-7, 8-9, 10-11 and 12-13 and originally actually intended to publish them this way. However, during the editing process it became clear that, due to the involved downsizing of the figures, this would provoke a reduction of their quality.

- Comment: "... results of regression analysis should be presented in the figures in a more pronounced way." - Response: Although all trend values are mentioned within the text, due to their high relevance it might be reasonable to also include them into the figures. Within the revised version of the manuscript the results of the regression analysis will thus be presented both in the text and in the figures.

- Comment: "Why is regression analysis only shown for the all-season-data and not also for summer and winter season separately? The authors mention that in the text, however, it is not indicated in the corresponding figures." (also cp. Referee 4) - Response: "The reason for this is the authors aim to keep the figures as clearly arranged as possible. An inclusion of the biannual trend lines into the figures would in many cases (e.g. Relative Humidity, Precipitation, Leachate and Evapotranspiration) not be beneficial as they would overlap and be optically hard to distinguish. In other cases, however (e.g. Air Temperature, Sunshine Duration), an inclusion of the biannual trend lines would be optically acceptable. Nevertheless, in order to keep a constant structure for all figures, the authors decided to mention the biannual trends only in written form. The only other way to include the biannual trend lines optically would be the illustration of all charts in separate figures. This, however, would triple the amount of figures and diminish the possibility to optically compare the annual and biannual graphs of each parameter.

- Comment: "The authors should provide more information about the quality of the

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regressions (i. e., correlation coefficients), and which method was used to make the regressions." (also cp. Referee 2) - Response: This topic can be either handled very extensively or rather shortly. The authors hold that it is sufficient to determine a method and a coefficient of determination and to take all decisions according to this within the analysis. Of course it is also rather common to include more information into the text. Nevertheless, the authors believe that within this context, the inclusion of more statistical values would not necessarily entail more valuable information for the interpretation of the mentioned trends. Yet, in order to clarify the regression method used in this study, in the following some basic information about it: - Method: Simple linear regression. - The regression coefficient calculated for the independent variable was simply the time axis. - Significance and p-values: This is set through the pre-analysis setting of the 95 % confidence interval. - Sensitivity analysis: A sensitivity analysis of trends was not performed. A Monte Carlo analysis of variability of trends would probably yield useful information, but was not performed within this study.

- Comment: "The authors refer to correlations between precipitation and leachate sums (p. 2633, l. 12; p. 2634, l. 15-16). Which method was used to calculate correlations, and why are results not shown?" (also cp. Referee 2) - Response: As the correlation between the annual precipitation and leachate sums is already optically visible (Fig. 8), the authors did not include the exact results in the text. However, the correlation coefficient amounts to 0,787.

- Comment: "The paper would benefit from the incorporation of more international literature." (also cp. Referees 2 and 4) - Response: The authors thought that all the relevant literature was well analyzed and, if applicable, cited. Any further hints or specific comments are welcome.

- Comment: "The authors should provide more information about how the lysimeter is operated." - Response: The large scale lysimeter site St. Arnold comprises three differently planted lysimeter basins (each of them with a width of 20 x 20 m and a depth of 3,50 m) made of ferroconcrete and filled with undisturbed soil (medium arenaceous

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podzol). The basins are not weighable, do not have ground water contact and the water sampling takes place on a zero-tension basis. The grass on the grassland basin is cut three to six times per year and, in order to eliminate moss, also gets verticutted twice per year.

- Comment: "Summing up precipitation from the summer and winter season, one gets the result that total precipitation was about 1400 mm in 2001. That seems quite high. The highest value mentioned in the paper is 1140 mm in 1966." (also cp. Referee 4) - Response: The authors kindly thank the referees for pointing out this mistake. The reason is a typing error concerning the decimal places of the precipitation value on 27.06.2001. This error will of course be corrected within the final version of the manuscript.

Referee 2:

- Comment: "Since the averages are made on the whole dataset and since the two tree forests are characterized by a growing period until 1990, the percentage values are not representative either for the growing period or for the equilibrium. The Authors should divide the whole dataset period into different intervals and make the water balance on homogeneous periods." - Response: The referees argumentation is comprehensible. Nevertheless, during the elaboration of the study, the authors regarded this as a further reaching point and therefore decided to merely mention the influence of the tree growth on the data sequence, but not to explore it in depth. Furthermore, the tree growth is more or less continuously. Therefore, "homogeneous periods" without tree growth do not occur.

- Comment: "The "version of Baumgartner and Liebscher (1990)" was adopted for actual evapotranspiration estimation. Why has it been preferred to Häckel (1993)?" What are the consequences? (also cp. Referee 3) - Response: The Baumgartner and Liebscher version is well accepted in the hydrologic literature. The authors deleted the Häckel parameters from the manuscript as they are not considered for computation.

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- Comment: [Referring to wind speeds in fig. 3] "At Pag 2628 line 14 it is said : While the former average out at 3.0 m/s, the latter average out at 1.0 m/s. In figure 3 the actual values of wind speed seem much lower. The wind speed at 9 m never reaches 2.5 m/s (average declared at 3 m/s) and the speed at 3m starts from 1.5 m/s and after 1976 it is always lower than 1/ms (indicated as the average value). - Response: Regarding the cited phrase, there is a misunderstanding on the side of the referee. The prior phrase in the manuscript says: "The wind speed chart in Fig. 3 illustrates the differences between the values obtained in the meteorological stations and in St. Arnold at heights of 3 m and 9 m." In the subsequent phrase (the one cited by the referee), "the former" refers to "the values obtained in the meteorological stations" and "the latter" to "the values obtained in St. Arnold". In other words: Each of the two mentioned averages ((A) 3,0 m/s and (B) 1,0 m/s) refers to one chart pair (pair (A): the two charts from the meteorological stations; pair (B): the two charts from St. Arnold). In order to avoid further misunderstandings, this phrase will be reworded in the final version of the manuscript.

- Comment: "The sentence at line 13-14 page 2633 by both the forests on and those around the lysimeter site is not clear." - Response: The entire sentence says: "In the case of St. Arnold, the grassland basin is surrounded by both the forests on and those around the lysimeter site." This is meant to express that the grassland basin in St. Arnold is surrounded by (A) the forests on the other two lysimeter basins, as well as by (B) the forests which are located around the entire lysimeter site. In order to avoid further misunderstandings, this phrase, too, will be reworded in the final version of the manuscript.

Referee 3:

- Comment: "Only trends of leachate rates are shown, not for the other meteorological records." - Response: The trends mentioned within this study are those of the leachate rates, as well as those of the actual and potential evapotranspiration, precipitation, air temperature, relative humidity, sunshine duration, global radiation and wind speed.

- Comment: "Add Penman (1948) and Monteith (1965) to the literature list." - Response: This will of course be made up for within the final version of the manuscript.

- Comment: "p. 2631, equ. (1): According to the literature, e.g. DVWK (1996, p. 37), (e*-e) is NOT divided by L. Please give reference for the equation. p. 2631, equ. (2): According to the literature, e.g. DVWK (1996, p. 53), L*DELTA must be added in the denominator. Please give reference for the equation." - Response: Both equations derive from the original publications of Penman in 1948 (in case of the PET) and Monteith in 1965 (in case of the AET). Nevertheless, literature today offers many specialized versions of both equations. As this study is meant to give a basic introduction to the data set collected in St. Arnold, it was decided to stand to the original versions. Furthermore note that the empirical function yields a value of dimension m/s.

- Comment: "How is ETa determined for the two forest lysimeters? How is LAI from Klein (2000) used for calculation of stomata resistance?" - Response: For the calculation of the AET of the two forest lysimeters, the original Penman-Monteith (1965) equation was applied (equ. (2) in the manuscript). The LAI values from Klein (2000) were used for the calculation of stomata resistance as follows: Step 1: Leaf Area Index of the sunlit leaves: $aLAI$ $aLAI = LAI * 0,5$ Step 2: Stomatal Resistance of single leaf: R_{si} ; Stomatal Resistance: R_s $R_s = R_{si} / aLAI$ For all calculations, data was primarily used on a daily resolution and afterwards added or averaged to annual values.

- Comment: "Schroeder (1989) reported Klein (2000) calculates interception from data measured by Schroeder. Why are these data are not used here?" - Response: One reason for this is that this data could not be retrieved for this study. Nevertheless, it must also be pointed out that the mentioned interception measurements only ranged from 1984 to 1990. Klein carried out his study in 2000, so his calculation was certainly less error-prone than a calculation for the subsequent years would be. Due to that, it might be more reasonable to first of all carry out further field studies in St. Arnold on this topic.

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- Comment: "Fig. 11 and 13: Evapotranspiration depends on changes in soil moisture. Thus, balance sums not up to 100% in summer and winter." (also cp. Referee 4) - Response: The balance term applies to both sub-annual (fig. 13) and annual (fig. 12) scales. Thus, changes in soil moisture cannot explain the observed phenomenon on an annual basis. Figure 13 only shows the according differences between summer and winter terms. It is only for the winter terms that the balance comes out even.

Referee 4:

- Comment: "More technical information about the different measurements would be useful." (also cp. Referee 3) - Response: The measurement devices used in St. Arnold for Sunshine Duration, Global Radiation and Leachate are already mentioned in the manuscript. In the following, more technical information about the other measurements carried out in St. Arnold (this will also appear in the final version of the manuscript): a) Precipitation: Hellmann pluviograph, ground level, adjacent to grassland basin b) Relative Humidity: Aspiration Psychrometer, 2 m height, adjacent to grassland basin c) Temperature: Thermograph, 2 m height, adjacent to grassland basin d) Wind Speed: Contact anemometers, 3, 6 and 9 m height, adjacent to grassland basin

- Comment: "The trend in the evapotranspiration values is taken as given by the tree development. What is the impact of the increasing temperature?" - Response: Although the increasing tree heights have a profound influence on the upward trend of the evapotranspiration values, the slight trend towards a milder regional climate certainly also plays a role. However, this aspect is also mentioned in the manuscript (cp. p. 2634, l. 17-20 and p. 2638, l. 22-26).

- Comment: "Figure 4: Subtitle in the graph (annual sums) is not appropriate." - Response: Figure 4 illustrates the annual quantities of trees on the two forest basins in St. Arnold. However, it is true that the addition "annual sums" to the title "Quantity of trees" might be confusing. This will be changed in the final version of the manuscript.

- Comment: "Figure 5: Same range on y-axis would be an advantage for visual com-

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parison." - Response: This will also be changed in the final version of the manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 2623, 2008.

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