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Hydrology and Earth System Sciences Discussions

Interactive comment on "Comparison of three measurement methods of saturated hydraulic condutivity" *by* C. Fallico et al.

C. Fallico et al.

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Reply to Referee #3

A - Answers to Major Comments

1. In our opinion the work we are presenting contains the following innovative elements: a) We choice to investigate three different measurement methods (TI), (PI), (SC), using different diameter, quite to point out the influence of such a parameter on the soil area and volume interested by water flow, in peculiar conditions that may not be found in other studies: e.g., disturbed conditions owing to the extirpation of grass. It's the latter factor that has provided to us the explanation of results quite different from other researchers on the same typology of soil. b) Soil core sampling (SC) soon after the ks-measurement by ring infiltrometer (PI), as well as the analysis of how the macro-

porosity of core samples could be influenced by the soil moisture, represent new operating conditions that, even in the light of the specific comment n. 19, provide a source of information about analogue measurement conditions c) Another element of innovation is the analysis of the determinant influence of the measurement method on ks-values, as well as, the analysis of how the measurement method is conditioned essentially by the specific typology of soil and less conditioned by the choice of the measurement location, as pointed out by the comparison between the ks-values measured in the same locations first by (PI) method and then by (SC) method. d) Furthermore, in our opinion also the considerations about (TI) and (PI) methods, specifically about the variation of the characteristic parameter by increasing the number of ks-measurements, represent elements of innovation of the paper

2. Perhaps it true: we emphasized too much the advantages of the (TI) method, even in the light of the assertion by Reynolds et al. (2000): “For the last decade, the tension infiltrometer (TI) method (Perroux and White, 1988; Ankeny et al., 1991; Reynolds and Elrick, 1991) has gained popularity for in situ measurement of near-saturated and saturated soil hydraulic propertiesĚ”. We can certainly agree with the Referee #3 when he points out the limitations of this ks-measurement method, moreover reported by other authors (Reynolds and Elrick, 1991; Reynolds and Zebchuk, 1996). It’s undeniable that the use of the (TI) method requires a lot of attention, as well as it’s undeniable that by this simple and quick method the disturb to the soil during the measurement process is almost of all absent (Elrick and Reynolds, 1992; White et al., 1992). Quite this consideration persuaded us to put (TI) method in comparison with invasive method like (PI) and (SC) ones Furthermore, to minimize the negative impacts of the (TI) method limitations (Wooding, 1968) we used the approach based on the extrapolation by negative pressures, using the Gardner relationship (1958) (Messing and Jarvis, 1993; Jarvis and Messing, 1995), jointly to Simultaneous-Equation-Appoach (Angulo-Jaramillo et al., 2000; Ankeny et al., 1991). Anyway, other authors had already recorded the low-rating of ks-values using (TI) method, whose flow conditions are three-dimensional, with respect to the use of other methods (PI), (SC) whose flow conditions are preva-

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lently vertical, above all in sandy media rather than loam ones. About the problem of local head loss due to contact material see the specific comment n. 2 and 3.

3. The diameter of the infiltrometer ring used in the (PI) method is about 10 cm, that is, the same magnitude of analogue instruments used in other studies (Reynolds et al., 2000). The diameter of the sampler used in the (SC) method, on the contrary, is about 4 cm, that is, a smaller diameter than that one of the ring used in the (PI) method. Such a diameter actually could be poorly representative, but several factors addressed us to this choice: a) by inserting such a small diameter in a soil portion very near to that one where previously it was been inserted the ring of the (PI) method infiltrometer, we intended to prevent that the core sample obtained resulted disturbed by the previous arrangement of the soil due to ring infiltrometer insertion. b) according to Bouma (1983), a bigger diameter was recommended, but the scope of our soil core sampling was wider than the ks characterization, concerning with other laboratories analysis for which the chosen diameter was an optimal one.

4. Actually our English was already revised by a mother-tongue lecturer. Anyway, we have no problem to admit that the text could still contain cryptic or not very fluid sentences. We apologize for it. We undertake to improve.

B - Answers to the Specific Comments

1 - P. 992, L. 17 -18 Ok, we replaced the correct terms: “silty” and “soil surface”.

2 - P. 993, L. 6 - 8 The required water-entry value of the white contact sand, used in the (TI) method measurements, is hwe = -22 cm; such a value was estimated according to Wang et al. (Z. Wang, L. Wu, Q.J. Wu, Water-entry value a san alternative indicator of soil water-repellency and wettability, Journal of Hydrology, 2000).

3 - P. 993, L. 13 - 14 The pressure heads on the membrane of the infiltrometer used in the (TI) method were fixed to the following values: -15 cm and -5 cm. The fixed pressure heads warranted an optimal adherence between the membrane of the tension

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disc infiltrometer and the contact sand, maintaining conditions of saturated flow in the soil and absence of de-saturated zone.

4 - P. 994, L. 1 We replaced the correct term: “sharpened lower rim”.

5 - P. 994, L. 12 We replace “the modality” with “normally”.

6 - P. 995, L. 4 - 8 The required figure will be provided in the revised manuscript.

The measurement locations involved in the (PI) method are displaced by chance, while those ones involved in the (TI) method are displaced according to 3 horizontal lines and 3 vertical lines. The measurement locations involved in the (SC) method are coinciding with those ones involved in the (PI) inside the restricted area. Such measurement locations are all included in the experimental site 20 x 40 m, which is in turn is included in a larger experimental area 40 x 70 m.

7 - P. 995, L. 17 “n” is the standard normal form of the main variable ks, that is: .

8 - P. 996, L. 10 - 11 (Table 2) The determination coefficient R2 expresses the fitting level of experimental data on the theoretical probabilistic distribution. This coefficient was calculated either for the normal distribution and the log-normal one. However, as suggested by Referee #3, other statistical parameters can be calculated for each distribution. Then, we revised the Table 2, reporting beside to R2, the skewness, the kurtosis and the coefficient of variation, either for the normal model and the log-normal one. As already pointed out on the basis of R2 computation, the new statistical parameters confirm that the log-normal model performs better than the normal one. Then, we reported in Table 2 the coefficient of variation, while in Table 3 we eliminated the standard deviation.

9 - P. 996, L. 17 (Table 3) In Table 3 we expressed the variation interval of each data sets by using the quantities kS max and kS min in place of the quantity A, replacing in the text the terms “amplitude” and “range” with the term: “Difference between max and minimum value of Ks”. Table 6 and 7 were modified in an analogue manner. Following

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the suggestion of Referee#3, we compared two by two the mean values related to the three data sets by using Tukey test and assuming a significance level of 0.05. Tukey test indicates that the comparisons between (TI) and (PI) mean values are significative, while the comparison between (TI) e (SC) mean values is not significative. Tukey test was added to the paper, as well as its results were inserted in Table 4.

10 - P. 997, L. 10 - 13 (Table 4) The heading “normal series” is replaced by “raw data”, while “ln-trasformated series” was replaced by “log-trasformed data”. T-Student test was applied to obtain the Pearson correlation coefficient, which was indicated with R in place of P. A significance level of 0.05 was assumed. Table 4 shows that Pearson correlation coefficient is very near to 1, particularly for the log-transformed data, except for the case (TI) vs (PI).

11 - P. 997, L. 14 - 16 In the light of Tukey test results - see specific comment n. 9 - we retain that there is no need to apply also the T-student test on the mean values. In fact, the T-Student test confirms the conclusion reported at specific comment n. 9, at least for the raw data.

F-test was applied on the data variances, with significance level of 0.05. Except for the log-transformed data in the comparison (SC) vs (PI), this test shows not significative differences in the comparison two by two of the other data sets. We are thinking to report just some comment on F-Test, without inserting new tables showing its results. Furthermore, in Table 5 we indicate an interval of values using root parenthesis and comma instead of dashes, in order to not create confusion with minus sign.

12 - P. 997, L. 23 - 29 We intended to point out just that a bigger data-sample is more representative of smaller one. Anyway we prefer to delete lines 23 - 25. Tukey-Test, applied to data sets collected in the larger experimental area, provides p = 0.9999 with a significance level of 0.05. This result shows the absence of a significant correlation between the mean values of (TI) and (PI) data.

13 - P. 998, L. 8 - 11 Table 7 was modified similarly to Table 3, adopting kS MAX e di

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kS min to express the interval of variation of ks.

14 - P. 998, L. 13 - 17 The interest of research related to field measurement of ks can be the following: - study of spatial variability analysis - comparison among different measurement methods and determination of the optimal technique; study of influence between a specific soil and choice of measurement method, etc In the sentence we are dealing with, we would underline that in the former case it's prevalently important the quantity of measurements, while in the latter one it's prevalently important the accuracy of the measurements. However, we can re-write this sentence as follows: "Describing the ks spatial variability being able to dispose of a greater number of measurements is determining; in other cases, however, the accuracy of data appears prevalent on the number (Lee et al., 1985)".

15 - P. 999, L. 8 We replaced the sentence: "Ěmodality of providing some waterĚ" with:"Ěmethod of applying waterĚ".

16 - P. 1000, L. 1 - 6 We agree with this consideration but we retain to clarify this point in the General Comment n. 2.

17 - P. 1001, L. 11 No problem to replace: "soil topper" with: "soil surface".

18 - P. 1001, L. 13 - 16 We agree with this observation but we want to state some practical aspects of our work: we had not the ownership of the experimental field. The operation of grass cutting was always made by the owner, who preferred the extirpation by hand, in order to slow down the new growth. These are the possible drawbacks of field activities.

19 - P. 1001, L. 24 to P. 1003, L. 7 We retain highly probable the hypotheses illustrated by the Referee #3. Then, we would add the following paragraph to page 1002, after line 9: "Probably the circumstance that the soil core samplers were inserted in the soil soon after the (PI) measurement was the determining factor. In fact, it's very probably that the wetted soil with fine texture met a consolidation with the collapse of macropores

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during the sampling operation. This consideration could explain why the straight line related to (SC) data in the fractal diagram shows a lower slope than that one related to (PI) data. According to the suggestion of Referee #3 we will report in the revised manuscript a scatter-diagram in which the (SC) data are compared with the (PI) data. This diagram, represented in log transformed scale, shows how ks-values derived by (PI) measurements are always bigger than ks-values derived by (SC) measurements.

20 - P. 1002, L. 24 to P. 1003, L. 1 We used the term “splits” as the term “cracks”. However we have no problem to replace “spilts” with “cracks”. The uncorrected term “swilling” was replaced by the corrected term “swelling”.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 987, 2006.