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Interactive Comment

# *Interactive comment on* "Influence of soil, land use and climatic factors on the hydraulic conductivity of soil" *by* N. Jarvis et al.

**Anonymous Referee #1**

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Overall I found the manuscript to be import and interesting. I defiantly believe it should be published, and is within scope of Hydrology and Earth System Sciences. Unlike many of the pedotransfer functions that exist, this paper has attempted to determine Ksat and K10 by insitu approaches, an approach I completely support. I had a few issues with the manuscript, I found the figures hard to interpret, I thought more could be made of the existing literature in relation to past efforts to measure Ksat, and reliability of pedotransfer functions. I would have been happier to see the machine learning approaches included in this publication given the poor correlations that were found.

Abstract I think it reads a bit blocky, and expression could be improved.

Introduction I think the introduction needs to start somewhat simpler. A description



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of what is infiltration, what is hydraulic conductivity, why are they important and how do they differ. Explain why knowing the rate that water moves through soil is so important for biological systems and modelling soil – water – climate – plant systems. You could also talk about how K is considered one of the most sensitive parameters for soil water modelling, catchment scale processes etc. P10847, Ln 8. . ..approaches often perform poorly. . .. I think this section needs greater detail, and more structure. Reasons why pedotransfer functions have difficulty predicting Ksat include; (i) range of measurement procedures used to asses Ksat vary both between and within databases. Ksat has been shown to vary enormously between different measurement approaches (ie Hardie 2013). Hardie reported a four order magnitude variation in estimated ksat based on methodology and antecedent moisture content, (ii) Hydraulic conductivity has been shown to vary enormously within small distances within the same soil (ie Davis 1999) and (Cox and McFarlane 1995) who found that the hydraulic conductivity of the B Horizon in a duplex soil varied by as much as two orders of magnitude over a 10 meter distance. (iii) sample sizes in the laboratory are often too small to capture the representative elementary volume of macroporous soils. Davis et al. (1999) found that measurement of saturated hydraulic conductivity in commonly small cores (6.3 x 7.3 cm) and constant head well permeameters were one to three orders of magnitude lower than for large cores (22.2 x 30cm) (Davis et al. 1999; Hutchinson and Moore 2000). Also field based measurements of hydraulic conductivity are frequently one to two orders of magnitude lower than values determined by calibration or inverse modeling (Brooks et al. 2004; Silberstein et al. 1999). (Vertessy et al. 1993) found that stream flow could be most accurately simulated using a lateral saturated hydraulic conductivity value which was nearly 10 times larger than the mean vertical saturated hydraulic conductivity measured using constant head well permeameters. (iv) hydraulic conductivity in vertic and water repellent soils is also influenced by antecedent soil moisture content which is not accounted for in pedotransfer models (Hardie 2012, Dekker and Ritsema, 2000; Lamparter et al., 2006, Greve et al., 2010;). (V) effects of macroporosity are not specifically accounted for (as you refer to).

In describing the importance of macropores you could refer to Poisuellie's law and the importance of a few large macropores rather than lots of small macropores ie (Watson and Luxmoore 1986) who determined that 96% of the water flux through a soil was transmitted through only 0.32% of the soil volume, namely the macropores.

P10847 Ln 25-30. I think more detail of the effects of climate, and soil moisture on soil structure are warranted. I suspect this should include reference to vertic soils, water repellent soils and soils which are subjected to seasonal freezing.

P10848 Ln 7. . ..In theory pedotransfer functions based on field measurement of ksat should give more accurate prediction of hydraulic conductivity than laboratory based methods. . .. . ..

Methods Need to include information of soil depth sampling in the methods

What about splitting / viewing the data by international soil orders.

P10850, ln 5-10 I think it should say . . .. . .in order to determine ksat from data determined at a range of supply tensions we . . .. . ..

I struggle with the analysis in so far as you recommend the use of machine learning approaches and suggest they are being developed but you haven't presented that analysis here. I would have suspected that they should appear here, especially as so many of the correlations appear to be non-linear.

Results I really struggled with figure 3. Can you somehow make what is represented by each row and column more apparent, ie Clay %, OM, Arable land etc..

Table 7. I think all the nomenclature should be in the figure texts, rather than having to refer back to other figures.

Also I would have liked to compare the regressions produced by simple regression techniques compared to the bootstrapping.

The identification of arable land as a binary factor in the prediction of ksat suggests



HESSD
10, C4730–C4735, 2013



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the data needs to be split such that separate pedotransfer functions are developed for arable and non-arable land.

P10854, ln 22: The low r2 values for the selected models needs to be discussed in more detail. This is really important part of the findings. Most pedotransfer functions predict Ksat with r2 values around 0.4-0.6. Your values are much lower, Why?. I suspect its due to most lab based studies undersampling the presence of large macropores and clay swelling, microbial blockage of saturated soil cores during analysis, thus resulting in lower ksat values but more importantly lower error terms between values due to the reduced importance of macropore flow. A table of your prediction factors and r2 compared to other pedotransfer functions would be really interesting. A good place to start is the back of (Cichota 2013)

P10855 Ln 0-5 I think this needs more discussion. Im not sure why disturbed soils have all of a sudden been brought into the discussion.

I though much of the short range spatial variation in Ksat at the catchment scale was due to macropore systems becoming more important during wetter conditions (Tsuboyama et al. 1994). Sidle et al. (2001) demonstrated that although individual macropore segments are generally less than 0.5 m in length, they have a tendency to self-organise into larger preferential flow systems which expand upslope as sites become wetter (Tsuboyama et al. 1994).

P10855, ln 17: compaction. I think this needs a bit more thought. What I suspect is not captured with the analysis is that bulk density only represents the total pore space in the soil, not how well the pore space is able to facilitate water movement ie bulk density doesn't measure pore connectivity, which may be more important for water movement than the total pore volume.

Important to recognise that land use and land management are different and should where possible be described separately. There are an enormous range of management factors that may influence soil porosity and ksat within arable systems.

I feel the manuscript is lacking a conclusion in which the authors recommend options for future development of pedotransfer functions.

Also I think the manuscript could do with a simple statement about the results in comparison to traditional pedotransfer functions namely. . . .. . .. . .That estimation of Ksat from field based determination of Ksat resulted in lower correlation with measured values than traditional laboratory based PTF. However the field based are thought to better represent the true flow rate and spatial variation in saturated hydraulic conductivity of in situ soils.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 10845, 2013.