REVIEWER # 2:

1. One part that is a bit of a concern in this study is the fairness of comparison between soil moisture distributions observed in the top 12 cm of soil and the topographic indices. In near stream, near saturated conditions, this comparison may be better supported than one would expect in up slope positions of the landscapes. I wonder what the Wet vs Dry results would look like if soil moisture values were treated with a binary filter (wet v. dry) and then compared to the TWI values. The authors could expand the text a bit to better develop the theoretical connections between TWI and soil moisture distributions. This would help balance out the discussion.

    RESPONSE: We anticipated that TWI-soil moisture correlations would break down in dry conditions as predominant controls on soil moisture patterns often shift from topography to evapotranspiration (Takagi and Lin, 2012; Grayson et al., 1997). We did not observe this (Figure A below) despite observing a considerable range in average soil moisture conditions over the course of the study (Figure B below). This may be because our sampling period started late in an unusually wet summer season and thus may not have captured the driest conditions during which evapotranspiration dominates the spatial organization of near-surface soil moisture. In addition, all of our field sites were in mid-slope positions such that that there were no dramatic transitions from near stream, near saturated conditions to dry upslope landscape positions. We added text to clarify and justify our site selection (lines: 155-157, 169-172) and we discuss the likelihood that the TWI-soil moisture relationship will breakdown under very dry conditions (lines 694-703).

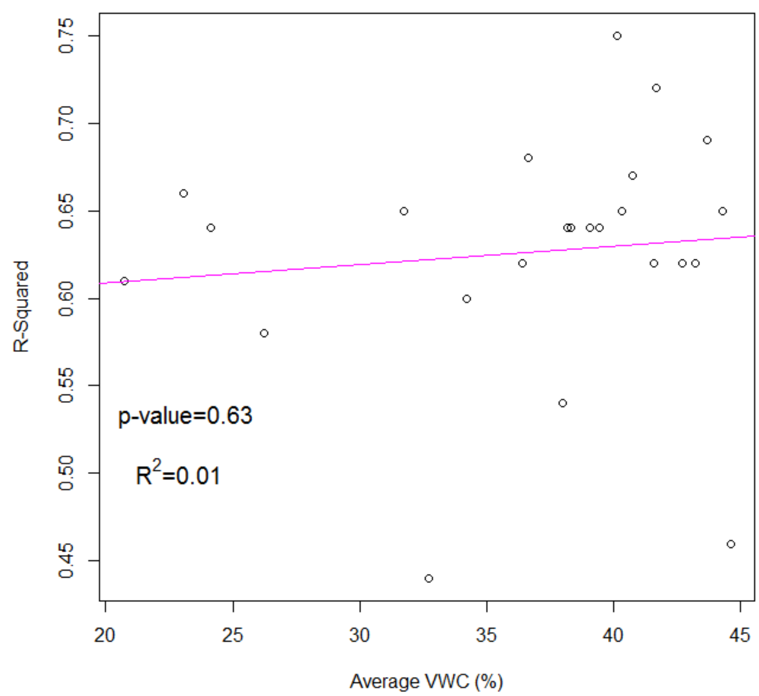

Figure A. Average R-squared value as a function of average volumetric water content (VWC) across sampling sites.

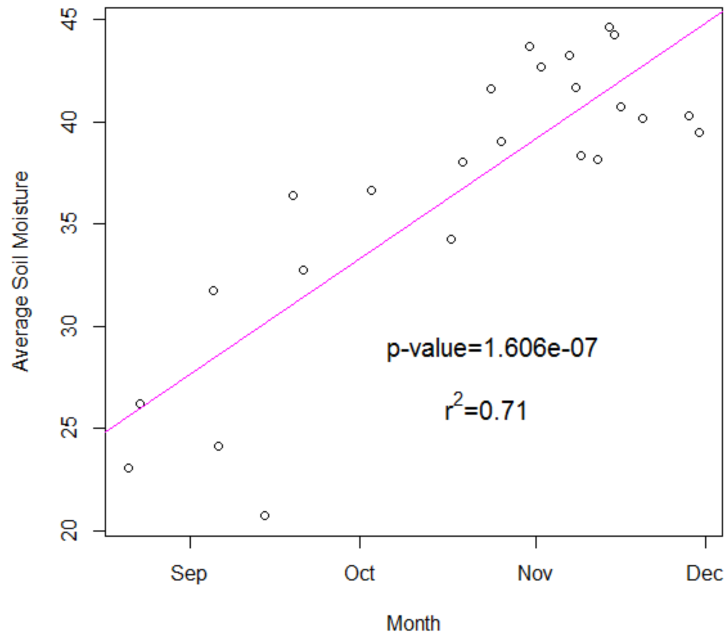

Figure B. Average field soil moisture content (%) as a function of date.

We are currently extending the original study to a broader geographic area, including a broader range of landscape positions and land cover types. Perhaps the upcoming future analyses will be able to better tease out the effects of dry vs. wet conditions on TWI-soil moisture relationships.

2. Why have all conditions (wet v. dry) been lumped together for analysis? Would you expect the same results under wet conditions versus dry conditions? I could imagine there been a hysteresis aspect to the landscape wetting up or drying down that could potentially come into play. This could be more thoroughly considered and the consequences put forward (either through analysis or discussion).

   RESPONSE: We tried to keep our sampling methodology consistent with a fundamental assumption of the topographic index – namely that of equilibrium flow. This is why we waited a minimum of 24 hours after a ¼ inch storm before collecting TDR measurements (see lines 178-180). Following this sampling protocol meant that our sampling frequency was not fine enough to properly capture hysteresis effects. Text to this effect has been added to the manuscript (lines 748-750). Our extended study plans to more thoroughly explore hysteresis effects by tightening the sampling frequency, especially during and after storms.

3. Experimental design: Did you divide the regions into various classes and then randomly select sampling locations within each class (a stratified random design)? A bit more detail there would help the reader judge the fairness of the field sampling in comparison to the calculated TWIs.

RESPONSE: All field sites were chosen on the basis of their proximity to the research facility (to keep driving times logistically feasible), land use characteristics, similar mid-slope positions, sites access, and minimal influence from subsurface drainage. The specific sampling points were chosen to cover the widest range of TWI-values at each site while also allowing for a reasonable sampling time, i.e., we tried to cluster sampling points along one or two loops. Text to this effect has been added to the manuscript. Please refer to lines 169-172.

4. I get the feeling that the authors might have missed the chance to make a statement about the relative contribution of each factor (e.g., LIDAR v. USGS; 3m v. 10m) in the overall error between soil moisture and TWI. It would be really interesting to see a breakdown of the amount of error due to these different factors in explanatory power for predicating soil moisture. Not exactly sure how this would look, but it would be in- formative to know that (for hypothetical example) 80% of the error or misrepresentation in a given representation was due to using USGS data while 20% was due to using 10 m resolutions. What is the (quantified) added value we get by going to LIDAR data at higher resolutions? You start into this a bit around the top of P14064, but do not fully develop it. I cannot think of an easy way to estimate this, but it could be taken as food for thought. Maybe adopting some simple comparative examples from your 432 variants and tracing out the explanatory power of the various factors in estimating the soil moisture values.

RESPONSE: We agree with the reviewer that this would be a helpful and worthwhile analysis. Unfortunately, this is a challenging suggestion to address for the following reasons:

1) It is not possible to quantify the absolute explanatory power of the individual variables in a mixed effects model.
2) A Relative Variable Importance analysis (RVI; Burnham and Andsersen, 2000) would shed light on the *relative* importance of the individual fixed and random effects in the mixed effects model. However, we had applied a statistical model (mixed effects) to evaluate the relative performance of a series of mathematical models (TWIs) which are themselves composed of numerous variables (slope, flow accumulation, etc.). It was not possible to decompose the mathematical models into their component parts and compare the relative explanatory power of each variable because some of the parameters were variables of TWI itself (i.e. slope, flow accumulation, transmissivity) and some were calculated on the TWI output (e.g. filtering of the TWI).
3) This rather interesting analysis would be most appropriate to undertake in a separate study as it would involve an entirely different methodology that would add significant length to an already lengthy paper. Such a study is currently being undertaken by a colleague (Katy Hoffmeister, Cornell Master's Student) as part of a separate project.

Analyses by other researchers do provide some insight into the relative explanatory power of terrain attributes. In general, they have found that upslope contributing area and slope explain the most variance in observed soil moisture patterns (Guntner et al., 2004; Brocca et al., 2007; Penna et al., 2009).

5. I really appreciate the effort made in section 3.7 of the text. I think this is clearly the heart of the study and its central contribution to topographic analysis literature. That being said, it is rather cumbersome to wade through (even with the help of Table 5). Would it be possible to add in a flow chart or a step-by-step walkthrough to guide the decisions of someone faced with picking an "optimal" TWI approach? Something that highlights "if this, then that" aspects and gives a method to guide to the best possible approach given constraints (like LIDAR v. USGS data). I am thinking along the lines of the walkthrough chart for evapotranspiration calculations provided in Maidment's Handbook of Hydrology.

   RESPONSE: We have added a flow chart which provides more explicit decision support guidance for readers. Please refer to Appendix A and to lines 688-689.

6. Minor/Editorial Comments
   a. P14042L5: Remove "in the US"

      RESPONSE: Change made.

   b. P14042L10: Change "; each field was visited 5-8" to "with each field visited 5 to 8".

      RESPONSE: Change made.

   c. P14044L28: Calculate "it" or "them"?

      RESPONSE: Change made.

   d. P14047L9: What is the impact of the resolution between 10m DEM and a 3m DEM when you use a fixed number of neighbor cells (four) rather than a fixed distance?

      RESPONSE: Bilinear interpolation of the TWI values at each sample point provides a distance-weighted average of the four nearest pixel values. So it is not necessarily a "fixed" distance or number of cells. We tested both simple TWI-value extraction (the TWI value for a particular point equals the value of the underlying raster cell) and bilinear interpolation for the USGS and LiDAR datasets. In both cases, bilinear interpolation provided better correlations with observed VWCs. This is now noted in the manuscript. Please refer to lines 196-200.

   e. P14056L26: Not clear what is meant with calibrated here.

      RESPONSE: Guntner et al. (2004) were able to improve the index performance by using soils data but only when they adjusted (calibrated) the transmissivity values to achieve a best match between predicted and observed soil moisture. They recognized that their soils data were only rough estimates and thus calibration was potentially justified within the range of parameter uncertainty.

f. P14057L6-8: How much does the 4 cell integration matter here relative to the change in resolution? See general comments. Could you quantify the impact?

RESPONSE: Please refer to our response to your comment regarding P14047L9. Also, bilinear interpolation likely resulted in a slight smoothing of the TWI values associated with each sample point. However, as we stated previously, we believe this yielded a more representative measure of the sampling point's true TWI value as our GPS units had a horizontal accuracy of ~3m.

g. P14063L11: Here and everywhere, check Table numbers.

RESPONSE: Corrections made. Thanks for catching that.

h. Conclusions: I do not really like the use of a structured list as a conclusion. I think more impact could have been made using a flow chart or decision tree. See general comment.

RESPONSE: Please see our response to comment 5.

i. Table 3 seems wrong in my printout. There was no information in there.

RESPONSE: Corrected

REFERENCES:

Brocca, L., Morbidelli, R., Melone, F. and Moramarco, T.: Soil moisture spatial variability in experimental areas of central Italy, J. Hydrol., 333(2-4), 356–373, doi:10.1016/j.jhydrol.2006.09.004, 2007.

Grayson, R. B., A. W. Western, F. H. S. Chiew, and Bloschl, G.: Preferred states in spatial soil moisture patterns: local and nonlocal controls, Water Resour. Res., 33, 2897-2908, 1997.

Penna, D., Borga, M., Norbiato, D. and Dalla Fontana, G.: Hillslope scale soil moisture variability in a steep alpine terrain, J. Hydrol., 364(3-4), 311–327, doi:10.1016/j.jhydrol.2008.11.009, 2009.

Takagi, K. and Lin, H. S.: Changing controls of soil moisture spatial organization in the Shale Hills Catchment, Geoderma, 173-174, 289–302, doi:10.1016/j.geoderma.2011.11.003, 2012.