Reply on RC3
Luca Comegna et al.

Author comment on "The hysteretic response of a shallow pyroclastic deposit" by Luca Comegna et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2020-362-AC4, 2021

OVERVIEW COMMENTS

Comment by Referee #3

Comegna et al. present an interesting dataset of soil moisture and suction and associated relationships over approximately one hydrologic year. As such, the manuscript is an interesting read and the data likely have utility for modelling. That said, the authors do not offer much in the way of suggesting potential uses of the data unless I just missed that somehow. There are also many issues to be addressed in revision. I provide specific comments below for consideration in revisions. In revision, I suggest the authors clearly address the value of the dataset beyond the presented use. Limitations should also be discussed.

Reply by Authors

Dear Referee #3,

many thanks for your comments, that will be very useful to improve the quality of the manuscript. Even though highlighted by many field and laboratory evidences (reported in literature and acknowledged in the manuscript), the hydraulic hysteresis of unsaturated soils is still often neglected by researchers involved in modelling the hydrological slope response to weather forcing for landslide prediction, who usually adopt a single Soil Water Retention Curve fitting all the available experimental data. Such choice is mostly made because the adoption of a more sophisticated retention model would require information about specific wetting/drying paths at different initial conditions that are frequently not available. The proposed paper is therefore aimed to provide data (monitored in-situ at a detailed time scale) on this point. We will try to better stress this point in the modified version of the manuscript. The replies to the specific comments are reported herein after.
SPECIFIC COMMENTS

R1 - Abstract, Line 10: Consider changing “concern” to “include”.
A1 – The suggested modification will be provided.

R2 - Abstract, Line 10: Rainfall is referred to as a height here and throughout the manuscript. Consider referring to it as a depth and change throughout.
A2 – Rainfall will be referred to as a depth, rather than a height, here and throughout the text.

R3 - Abstract, Lines 11-13: This entire sentence needs revision for clarity. For example, "...the installation at the same depths..." refers to installation of what specifically?
A3 – We will modify the sentence, specifying the installed instruments (tensiometers and TDR probes).

R4 - Abstract: In general, the abstract is not particularly informative and should be revised to more clearly explain what is being provided and of what potential use(s) that content serves.
A4 – The abstract will be simplified, clarifying the meaning of the provided information and the potential use.

R5 - Page 1, Line 27: The text "that prevents to reach" needs revision for clarity. The meaning isn’t clear to the reader.
A5 – The sentence will be replaced by “that does not allow full soil saturation”.

R6 - Page 1, Line 29, The text "If moving along one of these paths a reverse process is initiated" is awkward.
A6 – The sentence will be replaced by “If a reverse process takes place along one of these paths”.

R7 - Page 2, Lines 33-34: What is the point of this text?
A7 – The sentence “Concerning this point, Tami et al. (2004) report the results of some tests...” will be replaced by “This result has been experimentally recognized by Tami et al. (2004), through some tests...”.
R8 - Page 2, Line 36: TDR should be defined here.
A8 – TDR acronym will be defined here.

R9 - Page 4, Figure 3: The drawing of the soil moisture probes is misleading. From the text, they are either 10 or 40 cm long. 40 cm would be much longer than what is drawn. Also, Figure 3A is too small. It’s hard to read.
A9 – Figure 3a will be enlarged and Figure 3b will represent the soil moisture probes properly scaled accounting for their actual size.

R10 - Page 4, first line on the page: Consider changing “...concern the time period going...” to“...concern the time period from...”
A10 – The text will be changed following your suggestion.

R11 - Page 4, Line 60: The word “far” is not necessary here.
A11 – The word “far” will be eliminated.

R12 - Page 4, Line 62: “...precipitations...” should be “...precipitation...”
A12 – The word “precipitations” will be replaced by “precipitation” here and throughout the text.

R13 - Page 4, Line 62: Insert “by” before “warm and dry summer” to read, “...and by warm and dry summers.”
A13 – The text will be changed following your suggestion.

R14 - Page 5, Line 80: What is meant by “...some layers locally miss...”
A14 – The sentence “Some layers locally miss” will be replaced by “In some verticals, some layers were not found”.

R15 - Page 5, Line 83: Can the text “get dry and fall” be changed to “...Leaf senescence occurs in October...” or something like that.
A15 – The text will be simplified to “In October, leaves fall from the trees...”.
R16 - Page 5, Lines 86-88: This is a really long sentence and should be broken up a bit for clarity.

A16 – The sentence will be broken as reported in the follow: “The seasonal variations of vegetation affect the hydrologic response to meteorological forcing by i) interception of the precipitation and ii) root water uptake (Comegna et al., 2013). Interception is caused by canopy, understory and litter. The total evapotranspiration flux, distributed over the root depth according to the local value of soil water potential, is highly variable throughout the year owing to the dormant leafless vegetation in winter”.

R17 - Page 6, Line 92: What is “altered ash”?

A17 – The expression “Altered ash” is used to indicate a deteriorated ash layer with a grain size which is turning from silty sand to clayey and silty sand. We will clarify it in the text.

R18 - Page 6, Table 1: Need to define columns. Table should be able to be interpreted independent of text. Consider this for all tables in the manuscript.

A18 – We will clarify the used symbols in the captions of all the tables, in order to make their interpretation independent of text.

R19 - Page 6, Lines 94-97: Need to describe methods for determining these soil characteristics.

A19 – The reported soil properties have been provided by Damiano et al. (2012) through a number of geotechnical laboratory tests carried out both on undisturbed and remoulded soil samples. We will mention that in the text.

R20 - Page 6, Line 100: How many paired probes in total? What was the spatial sampling design? A table describing the location of all of your probes would be very helpful. And, introduction says data pertain to 2011 and 2012. Are these different data?

A20 – The automatic station installed in 2009, described by Comegna et al. (2016a), is equipped with eight “Jet fill” tensiometers and seven TDR probes. The two TDR probes described in the proposed paper have been installed at a planar distance of 50 cm from the corresponding tensiometers and their center is at a depth very close to the center of the ceramic tips of tensiometers. The information about the planar distance will be added in the text and will be brought to evidence in Figure 3b. As anticipated in Lines 58-59, the described monitoring data are available from January, 2011, to January, 2012. We will clarify in the text that data pertain to a time period of 13 months.

R21 - Page 6, Line 102: What kind a rain gauge? More detail needed on this and the “Jet fill” instruments, other instruments as well. Manufacturer, etc.
A21 – A specific table, reporting the main characteristics of the installed instruments, will be inserted (see the attached Supplement pdf file titled “Table_instruments”).

R22 - Page 6, Line 104: Should “...has been installed...” be “...was installed...”
A22 – The text will be changed following your suggestion.

R23 - Page 6, Line 105: 7 TDR probes or 7 metallic rods?
A23 – We mean 7 TDR probes (we will eliminate “metallic” to avoid confusion).

R24 - Page 6, Line 111: 100 or 400 mm? That’s a very large area for TDR measurements. More detail needed? Is this the same sampling area as the tensiometers?
A24 – The two TDR probes described in the manuscript are 40 cm long, while the tensiometer ceramic tips are 7 cm long. We have outlined in the text (Lines 121-122) that the suction and soil moisture transducers sample different soil volumes that might contribute to imperfect matching of suction and moisture data, mostly when respective profiles are characterized by strong gradients.

R25 - Page 6, Line 119: That is not what the following section describes. The structure of the paper is difficult to follow. Maybe a header to describe lab experiments here?
A25 – A header will be inserted to introduce the results of the laboratory experiments.

R26 - Page 6, Line 121: 40 or 10 cm? Does z equal the center or the bottom of the tensiometers and TDR probes?
A26 – The centre of the tensiometer ceramic tip is located at the same depth as the centre of the TDR probe.

R27 - Page 6, Line 122: How might the different volumes influence the results?
A27 – Due to the different soil volumes tested by tensiometers and TDR probes, any variation in suction and in water content variations is not simultaneously detected by the sensors. For instance, if the wetting front advances downward, the 40 cm long TDR probe can detect it with some advance compared to the ceramic tip of the tensiometers (the centres of the two sensors are aligned, so the upper edge of the TDR probe is some 16 cm above the upper edge of the tip). The temporal mismatch will be larger for steeper wetting front. A similar issue would affect the edges of the sensors during vertical (gravity-driven) drainage processes, while soil drying caused by root uptake is expected to be more evenly distributed throughout the entire root zone. These issues would certainly affect the
coupling especially in the initial stage of infiltration and drainage process, which are characterized by steeper gradients. However, the measurements are acquired every six hours, and looking at figures 7 and 9, it appears that suction and water content variations at the two investigated depths, 40 cm apart from each other, are detected nearly simultaneously. Hence, it is expected that the temporal mismatch may affect only one or two measurement points during each of the wetting/drying paths discussed in figures 8 and 10, which consist of many measurement points as they refer to long lasting processes.

R28 - Page 7, 123: How does this section relate to the field data collected? It would be good to be explicit here. Are these data included in your repository on Zenodo?

A28 – As reported in the text (lines 133-135), these lab results (included in our repository on Zenodo) allowed to hypothesize in the retention plane a reliable lowest boundary (i.e. the main wetting curve) for the field data. We will explicitly anticipate such a goal.

R29 - Page 7, Table 2 caption: What is “lowest water retention boundary” mean?

A29 – With this we intend to indicate the main wetting curve that represents the lowest boundary of the hysteresis domain in the retention plane, i.e. we assume that all the experimental points fall above or along this curve (never below it).

R30 - Page 8, Line 42: What do you mean by “cover”? Be more specific...litter cover, basal plantcover...?

A30 – We want to indicate the whole “pyroclastic cover”. The text will be modified.

R31 - Page 8, Lines 144-146: More detail on the local weather station is needed, since PET is referenced frequently.

A31 – These temperature data (shown in Figures 6, 7a and 9a) are provided at a hourly scale since 2002 by the Pietrastornina weather station, located at 495 m a.s.l. and 15 km from Cervinara, that is managed by the “Functional Centre for forecast, prevention and monitoring of risks and alerting for civil protection” of Campania Civil Protection Agency.

The mean monthly temperature used for the estimation of PET (Figure 4) have been instead calculated with the 1979-1998 monthly temperature data provided by the meteorological station of Montesarchio, managed by the National Hydrologic Service, located some 4 km from the test site at the elevation of 560 m.

Both the meteorological stations are very close to the considered slope and are located at approximately the same altitude as the field monitoring station. We will add all this information in the revised manuscript.

R32 - Page 8, Lines 160-162: This section needs some revision for clarity and to
point out “missing data” rather than “data lacks”. Also, the period of missing data is nearly half of the time you are highlighting. Why did you choose these two probes and this time period if there is such a large data gap?

A32 – The period with no data (“missing data” that will replace “data lacks” in the text) concerns about 35% of the monitoring period (going from January, 1st, 2011 to January, 31st, 2012). Such period has been chosen because, despite the declared gap, it allowed to recognize important aspects of the hysteretic hydrologic response of the investigated deposit.

R33 - Page 9, Section 3.1: Should provide an overview sentence here or table that explains that A-H are referring to specific dates (e.g. A = January 1st).

A33 – A table explaining the dates associated to the different letters will be added in Figure 8 and Figure 10.

R34 - Page 9: For the discussion on the various windows of time and associated trends, I think a graph of cumulative precipitation, ET, and soil moisture would be beneficial to the reader. Those allow the user to more easily see trends in wetting and drying in relation to water inputs (precip) and water losses (ET). I know previous similar studies have even looked at water input – evapotranspiration as a useful metric.

A34 – We see Reviewer’s point: the assessment of the water balance of the soil profile and, more specifically, of the investigated layers, would be useful for a more complete interpretation of the flow processes behind the observed hysteretic behavior. However, there are several reasons for which this kind of assessment (and the corresponding suggested graph) is not suitable in this case. First of all, there wasn’t a complete meteorological station operating at the slope, so it is not possible to evaluate ET (we have only mean PET). Second, the water balance should be completed also considering the leakage towards the underlying part of the soil profile. Third, the depth at which the shallowest sensors were installed (~60 cm below the ground surface) implies that part of the infiltrating water could be subtracted from the water balance at the considered depths because of possible (undetectable) variations of water content in the uppermost part of the soil profile. However, the discussed hysteretic behavior is detected by means of local measurements, and the observations remain valid also without information about what happened above and below the considered depths.

R35 - Page 9, Line 184: Units for “-1”?

A35 – Units “m/m” will be added.

R36 - Page 9, Line 186: Do you mean infiltration? If so, how about just saying that.

A36 – Indeed, we are discussing the effects of an infiltration process, but speaking simply about “infiltration” could mislead the reader, as it would not underline that the investigated soil layer receives water from the top but at the same time also releases
water towards the underlying part of the soil profile (so, what we see is the result of the (un)balance between infiltration and drainage).

**R37 - Page 9, Line 188: How is this threshold value determined?**

A37 – The field capacity is conventionally defined as the value of water content corresponding to a suction between 10 kPa and 33 kPa after a gravitational drainage process. Looking at the experimental points of figures 8 and 10, a value between 0.20 and 0.30 seems plausible, although the presence of intense root water uptake do not allow to clearly identify the effects of gravitational drainage alone.

**R38 - Page 9, Line 190: How is the curve fit?**

A38 – The plotted curve is just a manual fit. We will remark that in the text.

**R39 - Page 9, Line 194: The text “...starts growing further and further...” – what does this mean?**

A39 – “growing further and further” will be replaced with “flourishing”.

**R40 - Figures: For nearly all figures, the captions could be greatly improved to inform the viewer what is depicted. For example, the caption for the graphs in Figure 10 say nothing about what the different upper case letters represent. This same issue occurs in many of the captions. As another example, the inset figure for Figure 2 is not explained. Nearly all captions need substantial improvement for clarity.**

A40 – As suggested, the captions of all figures will be improved to give more information to the reader.

**R41 - Conclusions: Are the highlighted data consistent with the rest of the data?**

A41 – The highlighted data are consistent with the rest of the data.

**R42 - Data Availability: The data structure is not described at all in the paper. The description is central to the utility of the data for future analyses and a core component of publishing in ESSD.**

A42 – The repository Zenodo includes field data monitored in the investigated period (rainfall, temperature, suction and soil moisture) and laboratory infiltration test (shown in Figure 5). Such data have been collected in different Excel files. A brief description of how such spread sheets are organized will be added to the section “Data availability”, at the end of the manuscript.
Please also note the supplement to this comment:
https://essd.copernicus.org/preprints/essd-2020-362/essd-2020-362-AC4-supplement.pdf