

## Anonymous Referee #1

*Our answers to the reviewer comments are in italic, and the corrections to be included in the new version of the manuscript are in **bold black italic***

The combination of experimental laboratory data, field monitoring, geological aspects and the use and occupation of risk areas brings to the study a set of information that deserves to be divulged.

*We thank the reviewer for the comments and suggestions, and we are very pleased to see that our study is of general interest.*

However, some aspects of the study and the text should be evaluated. The following are some comments aimed at improving and clarifying some points of the work:

*We have addressed all comments and clarified several paragraph of the manuscript.*

Line 30 - A reference on the given information of the percentage of the population that lives in urban area in Brazil would be important.

*The reference was included.*

Line 39 – The reference to the removal of forests would not be removal of vegetation? Considering that it is already a deforested area.

*In response to the reviewer comment, line 39 of the manuscript originally said*

***Increased landslide hazard, for instance, has been related to the improper cut-and-fill construction of self-built housing on steep slopes, after the removal of forest cover.***

*And has been modified to:*

***Increased landslide hazard, for instance, has been related to the improper cut-and-fill construction of self-built housing on steep slopes, after the removal of vegetation.***

Line 66 – Typo: “Given the lack of detailed data” FROM.....Line 68 - The reference to numerical analysis is very broad. The numerical study was done with the flow analysis, but the stability analysis was done by equilibrium limit, which is not a numerical method.

*In response to the reviewer comment, line 66 of the original version of the manuscript was written as:*

*Given the lack of detailed data from historical landslides events in the municipality of Campos do Jordão, the aim of this study was to understand the factors responsible for triggering the landslides of early 2000 in Campos do Jordão using a numerical model of slope stability.*

*And has been modified to:*

*Given the lack of detailed data from historical landslides events in the municipality of Campos do Jordão, the aim of this study was to understand the factors responsible for triggering the landslides of early 2000 in the area using a numerical model that fully couple slope stability analysis with saturated/unsaturated transient pore-water pressure simulations.*

Line 93 – Figure 2 needs to be described in the text.

*We will included a short description of the landslides typologies in the introduction.*

*Landslides in the study area are classified as shallow, translational type, with depths of the rupture surfaces less than 2 m. Three different kinds of rupture processes are observed: the rupture surface occurs in the residual soil of undisturbed ground; the rupture surface occurs in the residual soil of a slope cut; and the rupture surface occurs in the base of the landfill deposit, or in the slope residual soil with mobilization of the overlying landfill. The last landslide types are more harmful since they mobilized larger amounts of material.*

Line 130 – Typo: Instead of lecture you mean reading?

*Line 130 was rephrased and merged with the next sentence (see below)*

Line 132 to line 137 – This paragraph is repeated.

*The whole paragraph was rephrased and merged with the previous sentence. The original paragraph was:*

*Soil moisture was monitored in the study area at regular intervals of 1 h to a depth 3.0 meters during 2016 using two EnviroScanTM (Campbell Scientific, 2016) probes installed next of the borehole SD-03 (Figure 2). Every EnviroScanTM 133 probes included six capacitance sensors that allowed the determination of soil moisture every 0.5 meter, thus is, at the depths of 0.5, 1.0, until 3.0 m deep. This distribution of depths allowed to monitoring moisture variations for those soil layers which are relevant to this study: landfill, residual soil and saprolite. Sensor calibration was based on the relationship provided by the manufactured (Campbell Scientific, 2016) based on dry and wet readings of each sensor.*

*And now is:*

***Soil moisture was monitored during 2016 at hourly intervals and to a depth of 3.0 m using two EnviroScanTM (Campbell Scientific, 2016) probes installed next of the borehole SD-03 (Figure 2). Each probe included six capacitance sensors that measured soil moisture every 0.5 m, thus is, at the depths of 0.5, 1.0, until 3.0 m deep, which allowed to monitor moisture variations of the landfill, residual and saprolite layers. Before the EnviroScanTM capacitance probes were installed in the soil, maximum and minimum values were normalized by matching the raw readings from each sensor at both 0% (held in air) and 100% water levels (submerged in water).***

Line 141 – Instead of Figure 3 it is Figure 4. The figure needs to be described in the text. Line 141 - The phrase seems truncated. The samples were not taken for stability analysis but for the determination of parameters that are used in the analyzes.

*As requested, the sentence was rephrased from:*

***SPT (Standard Penetration Test) boreholes and soil sample collections were performed at six (06) locations along the slope (SD-01 to SD-6) along three different profiles (Figure 3). Disturbed and undisturbed samples were taken under different geotechnical conditions for stability analysis of three (3) critical profiles of the study area (A-A'; B-B'; C-C').***

*To*

***SPT (Standard Penetration Test) boreholes were drilled along three profiles of the study site (A-A'; B-B'; C-C' in Figure 3) at six different positions along the slopes (SD-01 to SD-6, Figure 4). Disturbed and undisturbed samples were taken from the boreholes for the determination of the parameters used for stability analysis.***

Line 143 - The correct spelling is saprolite (saprolith seems to be Greek). This occurs along the text.

*The whole text was corrected*

Line 153 - The sentence is confusing and the order of the essay processes must be rewritten. For example: it is not the application of load that is made with a speed of 0.033 mm/min, but the phase of shearing.

*The original frase was*

**All samples were saturated and subjected to net normal stress of 25, 50 and 100 kPa applied during 24h with a constant velocity of 0.033 mm/min. The vertical 153 displacements were recorded during this period and after stabilization.**

*And was rephrased to*

**During the consolidation step, all specimens were saturated for 24h and subjected to net normal stresses of 25, 50 and 100 kPa. Then, in the shearing phase, a constant velocity of 0.033 mm min<sup>-1</sup> was applied. Vertical and horizontal displacements were recorded during the consolidation and shearing phases.**

Line 180 - The references to figures 3 and 4 are not clear. Where are the boundary conditions?

*It will be included a new figure in the text with all boundary conditions used in the seepage and stability analysis.*

Line 195 – It seems to be Figure 5 and not Figure 4.

*The correct reference is Figure 5 rather than Figure 4.*

Line 195 – Why to use a “sandy loam” if the classification used is not from agronomy?

*The soil classification in line 195 was modified from “Sandy loam” to “clayey sand” in accordance with geotechnical classification*

Line 209 – Typo: “.....soils representative of other Brazil.....”??

*The original sentence was:*

**The values of the resistance and Ksat parameters obtained in this study are comparable to other mean reference values of residual gneiss soils representative of other Brazil**

*And was modified to:*

**In addition, the values of the resistance and Ksat parameters obtained in this study are close to mean reference values of residual gneiss soils representative of other Brazil locations**

Line 211 – Instead of Figure 5 it should be Figure 6.

*The manuscript was corrected, and the sentence makes reference to Figure 6 rather than figure 5.*

Line 213 - Why not use field capacity?

*Due to the peculiar soil water behavior of tropical oxisols, the definition of field capacity in Brazil do not use the same threshold water potential values of temperate soils (Tomasella et al. 2000, doi:10.2136/sssaj2000.641327x), making comparisons among soils complicated. Therefore, we arbitrary adopted a value of -100 kPa, which approximately corresponds to dry soil conditions, since that threshold highlights the differences among the three soil types.*

Line 224 – The term “humidity” is used as water content. This does not seem correct.

*The sentence was corrected.*

Line 224 – Will the article be published in color? Otherwise references to colors should be retracted from the text and another reference system should be used.

*The publication has no restrictions regarding color figures, so we preferred to keep them as they are for facilitate readers understanding.*

Line 240 - It was not clear to me how the variation of moisture content led to the observation that soil parameters vary.

*Because the probes are installed close enough to assume that they receive the same rainfall amounts, we concluded that differences in the soil moisture behavior should be explained by differences in retention and conductivity properties. The original sentence was:*

**Contrasting differences in the soil moisture behaviour of the landfill deposit from the probes 3G1 and 3G2 clearly indicates that soil parameters variability is much higher in top layer.**

*And was modified to*

**Contrasting differences in the soil moisture behavior of the landfill deposit from the probes 3G1 and 3G2 suggest that the variability of soil parameters is higher in the top layer.**

Line 280 - For FS less than 1 ruptures should occur.

*As suggested by the reviewer, we modified the sentence in line 280 to:*

***“..., where ruptures should occur;...”***

Line 348 - Although it is reasonable, the analyzes do not seem to show that the condition of previous moisture content affects the analysis. It seems to me only an opinion.

*The paragraphs tries to emphasize the fact that, under the influence of leakage, previous rainfall history played a role since the factor of stability is lower previously to the large rainfall event of the end of the simulation period. This can be seen in more clearly in the profile B-B' of Figure 8: in the dry period between day 15 and day 22 after the beginning of simulation, it is verified a quick recovery of stability in the simulations that includes the effect of leakage (black curve), which is interrupted with the return of the rainfall. Since this effect was not clearly explained in the manuscript, the text was modified from:*

***Regarding the rainfall critical values use in early warning system by CEMADEN and the Civil Defense for the Campos do Jordão Municipality, our study showed that, although adequate for the event of 2000, the previous rainfall history played a fundamental role to create conditions favorable to the occurrence of landslides. In other words, the threshold currently used for issue early warning would result in false alarms under initial drier soil conditions.***

*To*

***Regarding the rainfall critical values use in early warning system by CEMADEN and the Civil Defense for the Campos do Jordão Municipality, although adequate for the event of 2000, our study show that the previous rainfall history, in combination with leakages, played a fundamental role to create favorable conditions for the occurrence of landslides. This is related to the fact that leakages contribute to keep the soil profile closer to saturation at the beginning of the period of more intense rainfall, and consequently the developing of positive pore-pressure conditions. In other words, the threshold currently used for issue early warning would result in late alarms under initial drier soil conditions, at least in heavily disturbed landscapes.***

Line 361 – The term “factor of slope safety” should be factor of safety of the slope or slope safety factor.

*The term “factor of slope safety” was modified to “slope safety factor” in the whole manuscript.*

Table 3 – Why not use m/s for hydraulic conductivity?

*We modified Table 3 and in the current version of the manuscript values are in  $m s^{-1}$*

Figure 2 - I suggest that the photos be separated to avoid the impression of continuity between them.

*As suggested by the reviewer, we modified the Figure 2.*

Figure 6 - Are the points indicated as small symbols experimental? If there are experimental points should be included along with Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss.

*Yes, the point in Figure 6 are experimental points. The methods used to obtain them are explained in the last paragraph of section 2.3. Additionally, the caption of figure 6 was expanded to clarify that points indicate measurements.*