We sincerely appreciate your thorough review and constructive comments on our manuscript. Your feedback has provided valuable guidance and will help improve the manuscript's structure and clarity. We have carefully considered each comment. Please find our detailed responses below, with author comments (**AC**) highlighted in blue.

RC2's comments:

The manuscript presents a case study on the 2015 Wye River-Jamieson Trask fire. It aims to investigate changes in soil properties after a fire and apply the measurements obtained to inform a hydrological model. Soil samples were collected at unburned sites with similar characteristics to those at nearby burned sites. In the lab, several soil tests were performed in the unburned samples and then, after burning them in a muffle furnace, in the burned samples. The hydrologic model was used to evaluate slope stability during rainfall events under unburned and burned conditions. The study is interesting and highlights the importance of informing models with real measurements. Some of the laboratory test results are very interesting, and I suggest more discussion of them should be developed. However, at this time the manuscript is a bit confusing, as it doesn't follow a continuous line of thought. I suggest a major revisions and restructuring of the manuscript before publication.

1. I would restructure the paper as follows:

    1. introduction,
    2. Materials and methods:
        1. 2.1. Scope of the study - Study area (move also section 5.2. here)
        2. 2.2. Soil sample collection
        3. 2.3. Laboratory burning test conditions: Laboratory burning tests
        4. 2.4. Numerical method: hydrological numerical method (name?) – model description and parametrization for this specific area.
    3. Results
    4. Discussion
    5. Conclusion

    - Line 129-191: should be in the result section.
    - Line 194-293: I suggest moving most of the equations to the supplementary materials (they take up a lot of space and this article is not intended to present a new model) and reducing the model descriptions to the essential information in the materials and methods sections.

AC: Thank you for reviewing our manuscript and offering valuable comments. We are pleased that you recognize the significance of our work and appreciate your comments on expanding the discussion of the laboratory test results and on restructuring the manuscript. In the revision, we will expand the discussion of the experimental results. Furthermore, we will reorganize the manuscript as you suggested to enhance its logical flow and readability by redefining the section divisions. We will reconstruct the content according to the revised outline. Below is a brief description of the revised section titles and their contents:

1. Introduction
2. Materials and methods
    2.1. Scope of the study – Study area (content from former Sections 2.1 and 5.2)
    2.2. Soil sample collection (content from former Section 2.2)
    2.3. Laboratory burning test conditions (content from former Section 3.1)
    2.4. Hydrological numerical method (TAG_FLOW): model description and parametrization for the study area (concise description of the numerical model and introduction to parametrization for the study area; content from former Sections 4.5 and 5.2)
3. Results
    3.1. Soil characteristics before and after the burning test (content from former Section 3.2, lines 129−191)
    3.2. Slope stability analysis (content from former Section 5)
4. Discussion
5. Conclusion

References

Supplement (content moved from former Sections 4.1−4.4, lines 194−293)

Comments:

1. Bushfire vs wildfire: wildfire is a general term that includes bushfires, and the literature you are citing is about wildfires. I would suggest changing the term since, as you mention at line 338, your study area is a large eucalypt open forest.

AC: Thank you for the constructive suggestion. We agree that wildfire is the more appropriate umbrella term for this study. Accordingly, we will replace each instance of bushfire with wildfire throughout the manuscript to align with the cited literature and more accurately describe that the study area is located at a large eucalypt open forest.

2. In general, you could use more citation.

AC: Thank you for your valuable suggestion. We agree that additional citations will strengthen our manuscript. We will review the relevant literature and add necessary references to support the arguments of this study.

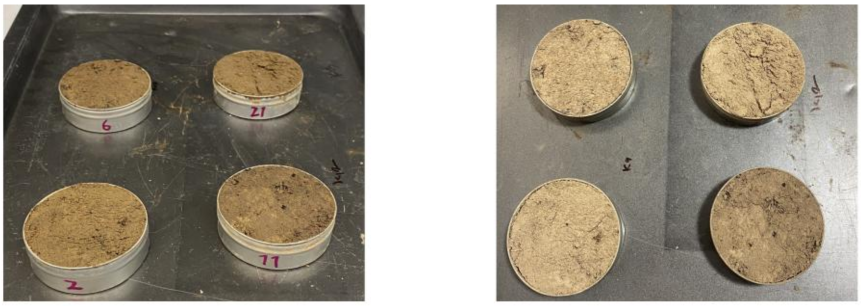
3. Laboratory burning tests: you should be more clear about the number of samples you collected in the field and the amount of repetitions of each test you did. Did you measure properties only once per sample or did you do repetitions? Are the values in Table 1 the average?

AC: Thank you for pointing out this important issue. During field sampling on the same unburned slope, we collected both undisturbed and disturbed soil samples. The undisturbed samples comprised: four cylinder samples A (62 mm diameter, 20 mm height; see **Figure R1a** below), two cylinder samples B (82 mm diameter, 42 mm height; see **Figure R2a**), and one block sample (30 cm × 30 cm × 30 cm; see **Figure R3**). Approximately 10 kg of disturbed soil was also collected (some of these samples are shown in **Figure R4**). Based on these samples, we conducted laboratory burning experiments and soil tests. The testing procedures and number of repetitions for the soil tests reported are explained in **Table R1** below. We will revise the manuscript to include essential additions regarding the samples and experimental procedures.

Table R1: Testing procedures and number of repetitions for soil tests.

Test results	Soil conditions	
	Unburned	Burned
Particle size distribution test	Disturbed soil samples were tested twice; observed deviations were within ±3–5%, and the mean of the two measurements was used (see **Figure R5a** below).	Disturbed soil samples after burning were tested using the same procedures as for the unburned samples (see **Figure R5b** below).
Moisture content, w (%)	Undisturbed soil samples consisted of four cylinder samples A; the mean of four measurements was used (see **Figure R1** below).	/
Wet density, ρ_t (g cm^{-3})	As above (see **Figure R1** below)	/
Dry density, ρ_d (g cm^{-3})	As above (see **Figure R1b** below)	Undisturbed soil samples consisted of two cylinder samples B; the mean of two measurements was used (see **Figure R2b** below).
Soil particle density, ρ_s (g cm^{-3})	Disturbed soil samples were tested using three specimens; the mean of their results was used (see **Figure R6a** below).	Disturbed soil samples after burning were tested using the same procedures as the unburned samples (see **Figure R6b** below).
Void ratio, e	The value was calculated based on the measured ρ_s, ρ_t and w, using **Eq. (1)** shown below (Lambe and Whitman, 1969).	For simplicity, the moisture content of burned soil samples was assumed to be zero; the same calculation method as for unburned samples was applied.
Liquid limit, w_L (%)	Testing was conducted on disturbed soil; results from three specimens were averaged (see **Figure R7a** below).	Testing was conducted on disturbed soil after burning; the resulting particles were predominantly non-plastic sand, so the measured liquid limit was zero (see **Figure R7c** below).
Plastic limit, w_p (%)	As above (see **Figure R7b** below)	As above (see **Figure R7c** below)

Plasticity index, I_p (%)	The value was calculated using **Eq. (2)** based on the measured liquid limit and plastic limit (Lambe and Whitman, 1969).	As above (see **Figure R7c** below)
Hydraulic conductivity, K (m s^{-1})	The test sample was an undisturbed block specimen; three replicate tests were conducted, and the mean result was used (see **Figure R8a** below).	A burning test was performed on the same block sample; testing followed the same procedures as for the unburned sample (see **Figure R8b** below).
Internal friction angle, φ (deg.)	Disturbed soil samples were tested in three replicates, and the mean value was used.	For disturbed soil samples that were burned, the same testing procedures as for the unburned samples were applied.
Cohesion, c (kN m^{-2})	As above	As above



(a) Wet undisturbed cylinder samples A (b) Undisturbed cylinder samples A after being dried

Figure R1: Cylinder samples A used for measuring pre-burn water content and wet density.

(a) Wet undisturbed cylinder samples B (b) Undisturbed cylinder samples B after burning

Figure R2: Cylinder samples B used for measuring post-burning dry density.

Figure R3: Undisturbed block sample.

Figure R4: Some of the disturbed soil samples.

Figure R5: Particle size distribution test.

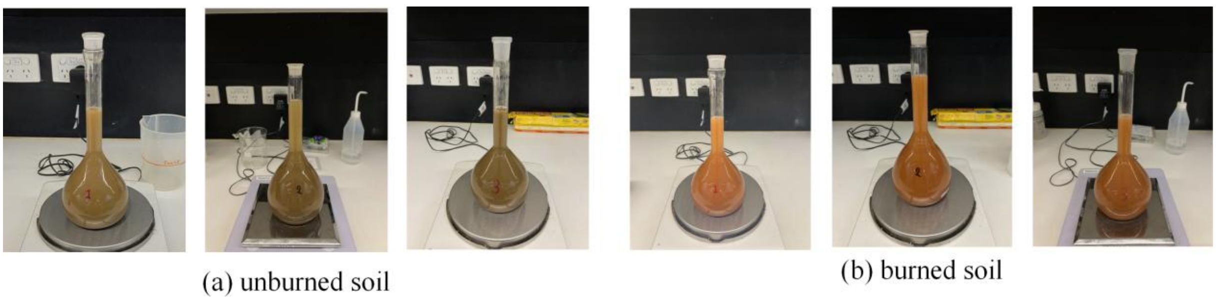


Figure R6: Soil particle density test.

(a) unburned soil for liquid limit test (b) unburned soil for plastic limit test (c) burned soil after 425 μm sieving

Figure R7: Atterberg limits test.

(a) unburned soil (b) burned soil

Figure R8: Infiltrometer test for hydraulic conductivity.

$$e = \frac{\rho_s\,(1+w)}{\rho_t} - 1 \ , \tag{1}$$

$$I_p = w_L - w_p \ , \tag{2}$$

4. The result and discussion section is poor. As suggested, after separating it, I would develop the discussion. Use a paragraph to explain future research needed to improve your laboratory experiments and the model.

AC: Thank you for your valuable comment. We agree that the Results and Discussion sections require improvement. We will split the Results and Discussion into separate sections and expand the discussion of the laboratory test results. We will also add a paragraph explaining the future research directions to refine experimental procedures and numerical modeling.

5. Line 21: are prevalent natural disasters: prevalent to what?

AC: Thank you for pointing out this ambiguity. We intended “prevalent” to mean “globally common”. We will revise the sentence to read:

“Wildfires are globally common natural disasters that burn approximately 350 million ha each year and intensify under global warming and drought.”

6. Line 23: Mediterranean: this is a climate region, which include a large part of the Western United States.

AC: Thank you for the correction and we accept this criticism. We intended to refer specifically to the Mediterranean Basin rather than the entire Mediterranean climate region. We will revise the sentence to read: *"Particularly affected regions include the Mediterranean Basin, the Amazon, the western United States, and south-eastern Australia."*

7. Line 49 – 62: lot of information about laboratory simulations, I suggest reducing it.

AC: Thank you for the constructive suggestion. We will condense lines 49−62 to provide a concise overview of the key advantages of laboratory burning simulations.

8. Line 64 – 68: You don't need to go in detail on the different models used by Stanley and Gartner. You can just refer to them as citation at the end of Line 65.

AC: Thank you for the constructive comment. We will simplify lines 64–68 by removing detailed descriptions of the models by Staley and Gartner and cite both references at the end of line 65. We will revise the sentence to read:

"Previous research on post-fire slope stability has primarily focused on erosion or debris flow initiation using historical data, empirical studies, or statistical models (Gartner et al., 2008; Staley et al., 2017)."

9. Line 86: simplified hydrological approach- based numerical method: does the method/model have a name? If so, mention the name.

AC: Thank you for the suggestion. The numerical model we used is named TAG_FLOW, and we will add its name to line 86. We will revise the sentence to read:

"Using the simplified hydrological numerical model named TAG_FLOW (Nguyen et al., 2022; Ozaki et al., 2021; Wakai et al., 2019),…"

10. Line 94: erupted: it is an uncommon word, I suggest using "started".

AC: Thank you for your correction. We accept this criticism and will revise the manuscript to replace "erupted" with "started."

11. Line 115-116: seems part of the introduction.

AC: Thank you for your constructive comment. We agree that the content in lines 115–116 serves as background and will move it to the Introduction to improve the manuscript.

12. Line 126-127: In caption Figure 3, information about the block soil sample measurements should also be added in the text. All soil sample measurement information should be included in the soil sample collection.

AC: Thank you for your detailed comments. In the revised manuscript, we will add an explanation of the block soil sample measurements in Figure 3 and list all soil sample measurement information in the "Soil sample collection" section.

13. Line 138-139: description of severity should go to the study site description.

AC: Thank you for your suggestion, and we accept it. We will move the description of burn severity to Section 2.1 (Scope of the Study – Study Area) to more appropriately present the context of the study area.

14. Line 58-159: should go in the discussion.

AC: Thank you for your constructive comment. We agree that the content in Lines 58–159 is better placed in the Discussion section and we will move it there in the revised manuscript.

15. Line 178: increase the permeability: This result is interesting because there are several studies in literature that state the opposite. I suggest discussing this result in more detail in the discussion section.

AC: Thank you for your positive comment and suggestion. We will expand the Discussion section to explain how this result contrasts with some existing studies and to examine possible reasons.

16. Line 302 – 305: can you explain better the source of these equations and how you calculate the cohesion and the angle of shear resistance of soil.

AC: Thank you for your helpful comment. In this study, we used the Mohr-Coulomb failure criterion ($\tau = c + \sigma \tan \varphi$) to determine the cohesion (c) and shear resistance angle (φ), where τ is the shear strength and σ is the normal stress. Specifically, for the unburned soil, the fitted equation is $\tau = 0.8193\,\sigma + 6.4119$; for the burned soil, the fitted equation is $\tau = 0.8463\,\sigma + 0.4462$. The fitted values were rounded to two decimal places. We will cite Terzaghi et al. (1996) as the source of these equations and include these equations in the revised manuscript to improve clarity.

17. Line 313-323: you are not presenting either methods or results. This should go in the introduction.

AC: Thank you for your comment. We will move this paragraph to the Introduction section to enhance the manuscript's logical coherence.

18. Line 318: clear ash within days: that ash that clogs the soil pores will not be cleared by wind (or if it does, please provide references), but it will move the ash that is in the top of the soil, which could create a permeable layer on top of the water repellent one that it is in the soil.

AC: Thank you for pointing out the ambiguity. We accept this criticism. We agree with your comment that wind can only move the ash at the top of the soil and cannot remove the ash that clogs the soil pores. The original phrasing was not sufficiently precise, thus resulting in misunderstanding. In the revised manuscript, we will replace *“clear ash within days”* with *“clear ash in the upper few centimeters of the soil surface within days”* to improve clarity.

19. Line 334-364: part of this section is part of the study area description, some on a chapter regarding model parametrization.

AC: Thank you for your comment. In response to your suggestion, we will make the following revisions to the manuscript:

- The description of the study area will be moved to Section 2.1 (*Scope of the study – Study area*) to consolidate the site background information.
- Content related to model parameter settings will be moved to Section 2.4 (*Hydrological numerical method (TAG_FLOW): model description and parametrization for the study area*) to provide a description of the numerical model parametrization process.

20. Line 356 – 357: you reduce the soil depth in the burned areas based on root concentration? Why?

AC: Thank you for your question. We have proposed two post-fire slope-failure patterns (please read Lines 311−333 of the original manuscript):

- **Short timescales (immediately to months post-fire):** Soil water repellency dominates. Ash particles clog pores in the upper few centimeters of the soil, increasing local repellency. Rainwater infiltrates only the upper layer and is blocked by the underlying hydrophobic layer, leading to pore-water pressure accumulation that induces surface runoff and erosion;
- **Long timescales (months to years post-fire):** Root degradation dominates. Root death and decay significantly reduce shear strength and generate new voids. Rainfall increases groundwater levels and pore-water pressures, triggering shallow failures.

This study focuses on rainfall events approximately ten months post-fire, during which slope failures were observed. These observations align with the long timescale pattern, in which root degradation dominates. According to Baldwin and Stewart (1987) and Grant et al. (2012), Eucalyptus root density typically peaks at around 0.3 m depth, providing the greatest reinforcement to the soil. Post-fire root loss at this depth causes the largest reduction in shear strength, making it the most likely location for a potential slip surface. Therefore, we set the post-fire maximum soil depth to 0.3 m to capture the dominant effect of root degradation on slope stability.

21. Table 2: give more information in the text on how you parametrized the model. Is it based on the laboratory analysis you did?

AC: Thank you for your constructive comment. We have added an explanation of the methods used to determine the parameters in Table 2. We will also revise the manuscript to include additional details on model parameterization.

1) **Initial saturation degree, S_{r0} (%):** Given the difficulty in directly obtaining the initial saturation degree, S_{r0} was calculated using the following equation proposed by Lambe and Whitman (1969), based on laboratory test results for water content (w), soil particle density (ρ_s), and void ratio (e) (see Table 1 in the original manuscript). The water content for the burned case was referenced from the unburned condition.

$$S_r = \frac{w\rho_s}{e\rho_w} \ , \tag{3}$$

where ρ_w is the density of water.

2) **Hydraulic conductivity, K (m h^{-1}):** Determined from infiltrometer tests in the laboratory (see Table 1 of the original manuscript).

3) **Saturated unit weight, γ_{sat} (kN m^{-3}):** Based on the laboratory test results of soil particle density (ρ_s) and void ratio (e) (see Table 1 in the original manuscript), the saturated unit weight (γ_{sat}) was calculated using the following equation proposed by Lambe and Whitman (1969).

$$\gamma_{sat} = \frac{\rho_s + e\rho_w}{1+e} g \ , \tag{4}$$

where ρ_w is the density of water and g is the gravitational acceleration.

4) **Wet unit weight, γ_t (kN m-3):** For the unburned case, the wet density obtained from laboratory tests was used; for the burned case, the dry density measured in the laboratory was adopted (see Table 1 in the original manuscript).

5) **Cohesion, c' (kN m^{-2}) and Internal friction angle, φ' (deg.):** Determined from laboratory direct shear tests (see Table 1 of the original manuscript).

22. Line 416 – 418: you mention a burn severity map. Did you parametrize the model in the same way for moderate and high severity burned areas? The impact on the soil is very different between the two severities. In addition, which severity are you simulating in the lab experiment?

AC: Thank you for the important comment. In the 2015 wildfire, high burn severity is defined by majority crown burn, whereas medium burn severity is defined by majority crown scorch, understory burn, and some crown burn. Laboratory experiments in this study simulated high burn severity conditions, representing scenarios in which vegetation was almost completely consumed and root systems were severely damaged. Although not the entire study area experienced high burn severity, with some zones subject to medium severity, the focus of this study is on the slope failures that occurred during post-wildfire rainfall, primarily located in high-severity burn zones near the Great Ocean Road. We acknowledge the reviewer's point that moderate and high burn severities can result in differing impacts on soil strength. However, due to the lack of available soil parameter data for moderate burn severity, high-severity parameters were uniformly applied in the modeling throughout this study. This approach represents a conservative assessment, potentially resulting in safety factors that are lower than those under actual conditions. We also recognize the limitations of this simplification. Nevertheless, it ensures that the potential instability hazard in moderately burned zones is not underestimated. In the revised manuscript, we will provide additional clarification regarding the simulated burn severity in the laboratory experiments, the reason for the uniform parameterization of burn severity, and the associated limitations. We will also outline future research aimed at refining model parameterization according to different levels of burn severity.

23. Line 434 – 438: the conclusions should be rewritten. You shouldn't repeat part of the introduction and methods in the conclusion.

AC: Thank you for your constructive comment. We will rewrite the Conclusions section to remove the repeated content.

Figures

1. Figure 1: I suggest adding a map of Australia because not all the readers would identify the location.

AC: Thank you for your suggestion. We have added a map of Australia to **Figure 1**, and the revised figure is shown below:

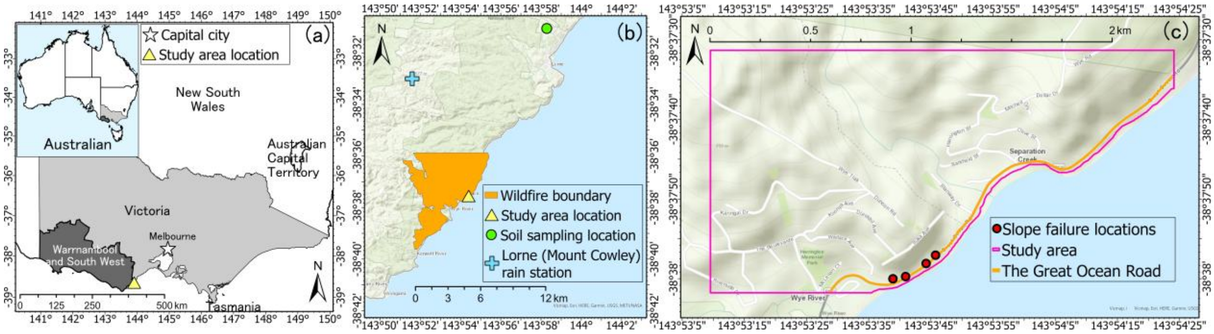


Figure 1: (a) Location of the study area (created using ArcGIS; data from the Australian Bureau of Statistics). (b) Spatial relationship among the wildfire-affected boundary, study area, and soil sampling locations (adapted from Colls and Miner, 2021). (c) Extent of the study area and slope failure locations (created using ArcGIS; data from ESRI).

2. Figure 1: I suggest adding a soil burn severity map (or the burn severity map from dNBR if you don't have on site measurements).

AC: Thank you for your valuable suggestion. However, on-site measurements of soil burn severity and sufficiently high-resolution dNBR products are currently difficult to obtain. Therefore, we are unable to include a soil burn severity map in the figure. We appreciate your understanding and constructive comments.

3. Refer figure 12 and 13 in the text and be consistent with the word use: Fig. or Figure.

AC: We accept the criticism. We will refer to Figures 12 and 13 in the text and ensure that all figures are consistent in format.

References

Baldwin, P. J. and Stewart, H. T. L.: Distribution, length and weight of roots in young plantations of Eucalyptus grandis W. Hill ex Maiden irrigated with recycled water, Plant Soil., 97, 243–252, https://doi.org/10.1007/BF02374947, 1987.

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Grant, J. C., Nichols, J. D., Yao, R. L., Smith, R. G. B., Brennan, P. D. and Vanclay, J. K.: Depth distribution of roots of Eucalyptus dunnii and Corymbia citriodora subsp. Variegata in different soil conditions, For. Ecol. Manage., 269, 249–258, https://doi.org/10.1016/j.foreco.2011.12.033, 2012.

Lambe, T. W. and Whitman, R. V.: Soil Mechanics, John Wiley & Sons, New York, 553 pp., ISBN 9780471511922, 1969.

Terzaghi, K., Peck, R. B. and Mesri, G.: Soil Mechanics in Engineering Practice, 3rd ed., John Wiley & Sons, Inc., New York, 512 pp., ISBN 9780471086581, 1996.