We appreciate Referee #1's careful review and insightful suggestions. We truly believe that the changes suggested by Referee #1 will enhance the quality of the manuscript.

Comments to the Author:

Wildfire is an important interference factor in the forest ecosystem. The occurrence and development of mountain torrents after a disaster has a complex mechanism, which is affected by many factors. Based on the precipitation obtained by hydrologic model and radar technology, estimate the identification threshold of flash floods after fire in the Southern California basin of the United States, and analyze the change characteristics of the threshold over time, providing reference for forest disaster prevention, disaster prevention and mitigation planning, and climate change adaptation in accordance. The article has a certain degree of logic and content, and the overall research is of strong practical significance. It can be included in this journal, but there are still some problems in the article, and it is recommended to modify it accordingly.

R: We appreciate the reviewer's insightful comments.

Introduction

This part of the content is the current research status and progress of flash floods after the disaster, and points out that it is impossible to use a single indicator to characterize the threshold of flash floods. However, it seldom describes the innovation and research significance of the article, and it is recommended to add relevant content and modify it.

R: Combining the calibrated model with radar rainfall data, we demonstrate the optimal rainfall ID metrics as flash flood thresholds and analyze the temporal changes of the optimal rainfall ID thresholds through the first five years of recovery following the 2009 Station Fire in Southern California, where is densely populated, fire-prone region.

On one hand, it provides insight into the trend of the flash flood thresholds following a fire in a chaparral-dominated environment similar to the southern California. On the other hand, the optimal rainfall ID metrics as flash thresholds identified in this study could be helpful when issuing flash flood warnings based on radar-derived precipitation estimates or data from several real-time rain gages within a watershed.

We added these content in Introduction.

"Results provide insight into the magnitude of temporal changes in flash flood thresholds in the densely populated, fire-prone region of southern California. Findings also provide guidance for the magnitude of change expected in rainfall ID thresholds for flash floods during the post-fire recovery period in chaparral-dominated environments similar to southern California. More generally, results support the development of early warning systems for flash floods by identifying specific metrics that can be computed using spatially variable rainfall intensity estimates to assess the potential for flash flooding. The optimal rainfall ID metrics identified in this study could be helpful when issuing flash flood warnings based on radar-derived precipitation estimates or data from several real-time rain gages within a watershed."

Research area

â The format of the title of the article is not uniform. For example, "Figure 1, Figure 2 and Fig. 4" suggest to unify the format and modify it according to the requirements of the journal.

R: The format of all figure title is modified according to the journal's requirements.

â The article is rigorous in description and rich in content, but there are some detailed problems, such as the inconsistent citation format, (Staley et al., 2014). and (Oakley et al. 2018a). It is recommended to organize and modify according to the requirements of this journal.

R: We modify all citations in the format of the journal.

Data and methods

â The article estimates the value of precipitation based on hydrological models and radar technology. It is recommended to explain whether the result has passed relevant verification.

R: The precipitation is estimated from radar observations, which are archived for the two operational NWS Next-Generation Weather Radar installations (NEXRAD; NOAA 1991) that cover the study area, KSOX, (Santa Ana), and KVTX (Ventura). The reflectivity (R) data is then converted to precipitation by using five well-known and previously published Z-R relationships were applied to the gridded reflectivity values. Supplement S3 lists the different Z-R relationships applied here and the general conditions for which they are suitable.

â¡The article points out that after wildfires, mountain torrents erupt, saturated hydraulic conductivity on hillsides and hydraulic roughness in river channels play a decisive role, but whether it is necessary to consider the situation of burned sites, channel conditions, underlying surface conditions, and development history. Consider only the rainfall intensity, one of the material sources of the flood.

R: Good point. Many factors can affect the occurrence and magnitudes of post-fire flash floods. However, we employ a well-calibrated hydrological model for the upper Arroyo Seco (Liu et al., 2021), in which many factors have been considered, to explore changes in rainfall ID thresholds following disturbance in the study watershed. For other watersheds, it is necessary to consider all important factors when using a hydrological model to infer rainfall ID thresholds.

â¢The article is based on the K2 hydrologic model to simulate rainfall division, surface watershed and flood path. This model has relative advantages over other hydrologic models. In this study area, this hydrologic model has fewer verification links and overall adaptability evaluation descriptions. It is recommended to consider adding related information.

R: KINEROS2 (K2) is an event-scale, distributed-parameter, process-based watershed model, which has been used extensively for rainfall-runoff processes in semi-arid and arid watersheds (Smith et al., 1995; Goodrich et al., 2012). Specifically, this model has been well calibrated using rain gage data in combination with the USGS stream gage installed at the outlet of the upper Arroyo Seco watershed during different stages of the post-fire recovery process (Liu et al., 2021).

â£This paragraph is rich in content and complete in structure, but there are still some details. It is recommended to organize and modify it. For example, "It is written in the text (Table S1) but this table does not appear. The format of the table is recommended to be modified according to the journal's requirements. The three-line format shall prevail , So that readers can read and understand".

R: Table S1 is included in Supplements (S2) according to the journal's requirements.

Results

There are some detailed problems in the content of this paragraph. For example, "the horizontal and vertical coordinate units of some charts are not marked" are suggested to be added so that readers can understand the relevant content.

R: Y axis labels of Figure 10 have been added.

Discussion

This paragraph points out the significance of the optimal measure of rainfall intensity after a fire for flood warning and the increase in rainfall intensity threshold over time.

â It is recommended to increase the comparison between the research of this article and the research conclusions of other scholars, as well as the existing shortcomings.

R: Good suggestion. Comparisons can be found in Discussion section 5.1.

"Previous work has also identified that 30-minute rainfall intensity works well for predicting flash floods and debris flows (Moody and Martin, 2001; Kean et al., 2011; Staley et al., 2013). The finding that I_15^j, I_30^j and I_60^j work best as thresholds when $75{\leq}j{\leq}85$ could be helpful when issuing flash flood warnings based on radar-derived precipitation estimates or data from several real-time rain gages within a watershed. Current operational forecast models such as the High Resolution Rapid Refresh model have a horizontal resolution of 3km and minimum temporal resolution of 15 minutes (Benjamin et al., 2016; NOAA 2021a), such that it is feasible to use either I_15^j, I_30^j or I_60^j in an operational forecast setting. Where sufficient operational NEXRAD weather radar coverage is present, radar-derived precipitation estimates such as the MRMS (Zhang et al., 2016) can provide near-real-time precipitation estimates at 1 km and as fine as 15 min temporal resolution (NOAA 2021b). In the case of poor radar coverage, gap-filling radars may be temporarily deployed or installed (e.g., Jorgensen et al., 2011; Cifelli et al., 2018) to provide information necessary for accurate precipitation estimates. While the magnitude of rainfall thresholds estimated here may only work for similar, recently burned watersheds within the San Gabriel Mountains, this work provides a general methodology for exploring reliable predictors of post-fire flash floods for other watersheds and settings. Further testing is needed in watersheds with different watershed size, topographic characteristics, landscape, and burn severity patterns."

â¡There are some detailed problems, it is recommended to sort out and modify them, such as "It is written in the text (Figure S3) but this picture does not appear".

R: Figure S3 is included in the Supplement.

â¢The title of 4.2 "Increases in rainfall intensity thresholds with time since fire "is similar to the title of 5.2 "Increasing rainfall intensity thresholds with time since fire". It is recommended to modify it for readers to understand.

R: Good point. We changed the title of 5.2 into,

"The role of hydrological models in rainfall intensity threshold estimation."

3

Conclusion

It is recommended to classify and elaborate the main research conclusions of the article for readers to understand.

R: We have modified Conclusions section as follows,

"We used 250 m, 5-minute radar-derived precipitation estimates over a 41.5 km2 watershed in combination with a calibrated hydrological model to estimate rainfall intensity-duration thresholds for post-fire flash floods as a function of time since burning. The main outcomes of this study are 1) identification of optimal radar-derived rainfall metrics for post-fire flash flood prediction in southern California, 2) estimates of temporal changes in rainfall ID thresholds for flash floods following disturbance in a chapparal-dominated ecosystem, and 3) a methodology for using a hydrological model to assess changes in post-fire flash flood thresholds.

Results indicate that thresholds based on the 75th-85th percentile of peak rainfall intensity averaged over 15-60 minutes perform best at predicting the occurrence of a flash flood in our study area. In other words, a flash flood tends to be produced when rainfall intensity over 15%-25% of the watershed area exceeds a critical value. A threshold based on I_30^{75} performs consistently well for post-fire years 1, 2, 3, and 5, although the magnitude of the threshold increases with time since burning. For the watershed studied, the I_30^{75} threshold increases from 16.0-16.8 mm/hr for year 1 to 23.2-26.9 mm/hr, 26.9-32.6 mm/hr, and 27.6-34.5 mm/hr, for years 2, 3, and 5 respectively. Increases in the threshold value of I_30^{75} can be primarily attributed to increases in Ksh rather than nc during the hydrological recovery process. The increase in the magnitude of the threshold from year 1 to year 2 is consistent with previous observations from nearby areas in southern California. Results provide a methodology for using radar-derived precipitation estimates and hydrological modeling to estimate flash flood thresholds for improved warning and mitigation of post-fire hydrologic hazards. Thresholds developed through these methods can then be built into operational tools that use incoming radar data to evaluate flash flood hazard in near-real time or precipitation forecasts to evaluate potential for flash flood hazard in burned watersheds."

References

â Some cited documents do not have a year and are unified in accordance with journal requirements.

R: The references list is updated.

â¡The format of URL addition is not uniform, for example, line 485 is from https://journals.ametsoc.org/view/journals/mwre/144/4/mwr-d-15-0242.1.xml. Others are added directly.

R: This reference (line 482-485) is updated.

It is recommended to make unified rectification in accordance with the requirements of the journal.
â¢The font size in the text are not uniform. For example, "35 of line 491, 31 of line 518, and 5 of line 556 are bold fonts, but other references do not have this format, and it is recommended to be unified".

R: The font size and style are updated.