Dear Editors and Reviewer:

Thank you for your letter and for the reviewers’ comments concerning our manuscript entitled “Determination of the runoff threshold for triggering debris flows in the area affected by the Wenchuan Earthquake”. Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches. We have studied comments carefully and have made correction which we hope meet with approval. The main corrections in the paper and the responds to the reviewer’s comments are as flowing:

Responds to the reviewer’s comments:

1. Abstract: (page 4660 line 3) “including channel width, median particle diameter,”The “median” particle diameter is different from “mean” particle diameter in page 4663.The authors should check the inconsistence. Furthermore, some significant resultsshould be highlighted in the abstract.

Responds: thanks for the suggestion about abstract. The results have been highlighted in the abstract. and the **new abstract** is as following:

We constructed 61 experiments to determine the critical runoff discharge for debris flow initiation in Wenchuan Earthquake area. A single dimensionless discharge variable was integrated to incorporate influential parameters, including channel width, median particle diameter, surface flow discharges and channel slope. The results revealed that in all experiments the debris flow bulk density increases with the dimensionless surface discharge, and the increasing ration increases with slope, showing the critical effect of slope and surface runoff discharge to debris flow prosperities. Debris flows was regarded as forming as the density exceeding 1.3 g/cm^3, then taking into account the behaviors of debris flow formation corresponding to different ranges of slopes, the critical runoff thresholds for debris flow initiation were calculated for three different scenarios as $Q=40\frac{dg^{0.5}D_M^{1.5}}{(\tan\theta)^{0.1}}$, ($\Theta$=12±2), $Q=2.4\frac{dg^{0.5}D_M^{1.5}}{(\tan\theta)^{2.1}}$, Θ=17±3, and $Q=6.3\frac{dg^{0.5}D_M^{1.5}}{(\tan\theta)^{1.08}}$ Θ=22.5±2. The results were compared with other previous studies, and validated against actual debris flow events, showing the applicability in the Wenchuan Earthquake area.

As for another comment, actually, it is a miswriting and thanks for pointing out this, and we have corrected it as taking place all the “mean” in the manuscript by “median” particle diameter.

2. Experimental design: (page 4663 line 17) “The laboratory flume (Fig. 2) had a length of 300cm a width of 20cm and a depth of 250cm depth.” The symbols used in equations (2) and (3) should be added in fig. 2. The depth of 250cm is different from that in fig. 2.

Responds: Thanks for pointing out this miswriting. The “250 cm” in the manuscript should be replaced by “25 cm”

3. Critical equations for debris flow formation: (page 4666 line 3-11) “This classification of the critical conditions can be explained as follows:” It is not clear whether the reasons were based on the experimental processes and results. More experimental results should be illustrated in the paper.

Responds: Special thanks for this suggestion. The experiments process is necessarily required because that is the basement of the results analyzing, and another reviewer also point out this absence. So not only the experiment results, but also the experiment processes have been added the experiment introduction in the revised manuscript (**4.1 Experimental processes and experiment data**):

For the experiments with slope as 12±2° inclination, the debris flow initiated with rill erosion, then the rills was down cut and deepened. Then the rill side failed and deposited landslide deposited formed. Ultimately the dam failures mixed the discharge and formed debris flow. The whole processes lasted in 15-20 min.

For the experiments with 12±2° slope, the initiation mechanism was erosion-debris flow. Similarly with the previous experiments, the rills formed in the beginning, then the soils was eroded headward synchronous with down cutting and side erosion. After the rills were widened, lengthened, and deepened, the density and discharge of the materials downwards were increased. Although landslides occurred at the rill sides, they were transported instantly by the sufficient hydrodynamic of surface water discharge and formed debris flows. during this processes, the seepage incorporated transportation duration range 2.5-5min, deposits failed from the toe, nevertheless, it provided small percentage volume for debris flows and is not the main debris flow formation type.

For the experiments with 22.5±2.5° slope, the debris flows formed more easily and quickly. Surface flow incorporated into soil body, and fluidizing the deposit shorter than 30 s. then the deposit failed from the toe, subsequently, debris flow formed as the deposit body slide down in a short time, no longer than 1 min .

4. Comparison with other studies: (page 4667 line 14-15) “Our results are similar to those of Takahashi (1978), and intermediate between Gregoretti (2000) and Tognacca et al. (2000), as shown in Fig. 7.” The experimental material and the definitions of dimensionless surface discharge and debris flow formation in those studies were different, which makes the comparison unclear. Moreover, the results are more similar to those of Tognacca et al. than those of Takahashi.

Responds: Special thanks for this suggestion.

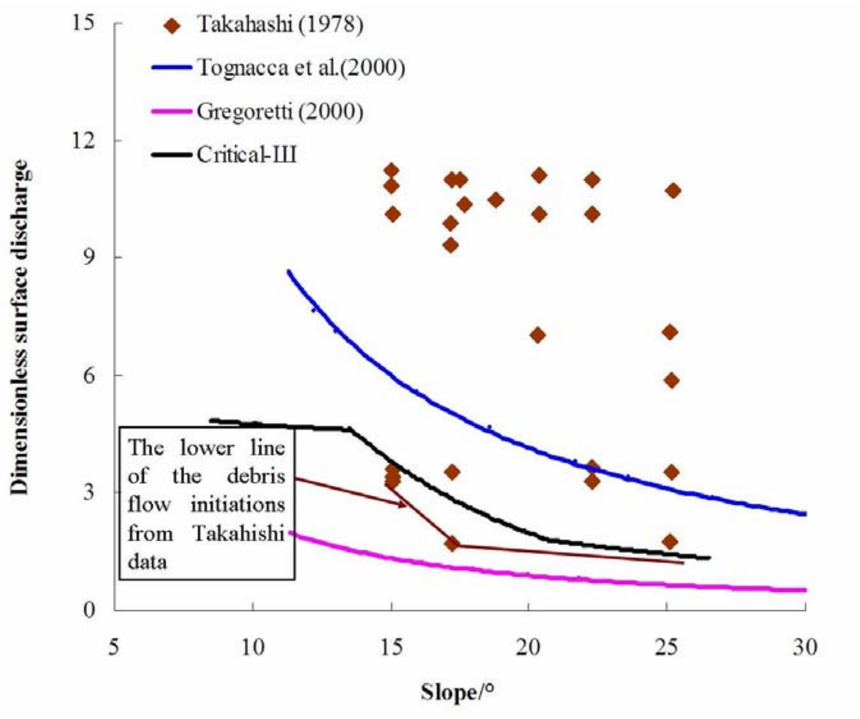
With regard to the definitions of dimensionless surface in the relevant studies, we have to say that the definition in this study followed that proposed by Gregoretti (2000). As our understanding, Tognacca et al. (2000) did not consider the relative density in the experiment design, and it is the same with our experiment, when dimensionless the water discharge. However, Gregoretti, (2000) considered the relative density in his expression. According to Gregoretti and Fontana（2008）, a dimensionless method was proposed by considering the density to have a comparison with others. The dimensionless surface discharge was expressed as:

$$q^* = Q / \left(\left(\rho_s / \rho - 1 \right)^{0.5} g^{0.5} D_M^{1.5} \right).$$

This study followed this expression, and discussed below the equation (7) as :

Where $q^* = Q / \left(\left(\rho_s / \rho - 1 \right)^{0.5} g^{0.5} D_M^{1.5} \right)$ is the dimensionless critical discharge per unit width, and ρ_s and ρ are the sediment and water densities, respectively.

As for the results, the results of the this study is higher than Gregoretti (2000)`s and lower than Tognacca et al. (2000)`s. If we linked the lowest events in Takahashi (1978), as shown in the figure below, it was found that our results are similar with that proposed by Takahashi (1978). And most of the experiments events in Takahashi (1978)`s experiments were above our thresholds lines. With regards to the events that lower than our lines, we have a discussion in Section 5.1, that may be caused by the criterion of debris flow formation. In our study, we assumed that a debris flow forms at a bulk density greater than 1.3 g/cm3, which is a widely used convention in China (Kang et al., 2004). However, in most of other studies, the onset of the scour was assumed to coincide with the critical condition for the initiation of debris flow.



5. Comparison with otherstudies: (page 4668 line 5-6) "we used a loose soil comprising about 3.5% clay, which is similar to that used by Takahashi (1978)." The experimental material in this study doesn't seem to comprise about 3.5% clay according to the particle size distribution in fig. 3. Moreover, the particle size distribution of experimental material of Takahashi, Gregoretti, and Tognacca may be added.

Responds: It is a good suggestions and surveyable if these particle size distribution of materials used can be listed in a same figure. However, in the previous studies, their particle size distributions were not completely listed. Hereby we listed the median diameter of the materials in the following table.

The materials applied in previous studies and this study

Material	Slope range	D_{50} (m)	Studies
Quasi-debris	12-25	0.0053	This study
Gravel	12-20	0.023, 0.029,	Gregoretti (2000)

		0.034	
Materials with clay	0-30	0.0058, 0.003	Takahashi (1978)

6. Validation of the model: (page 4669 line 1-2) “the runoff at different rainfall frequencies by the method known as the. (Eq. 7),” The eq. (7) is the dimensionless critical discharge; the authors should interpret how to use this equation to calculate the runoff at different rainfall frequencies. Moreover, eq. (9) should be interpreted further.

Responds: Actually, this is another careless mistake and thanks for pointing out this. Eq. 7 should be replaced by Eq. 9.

Eq.9 is an empirical equation for calculating the runoff discharge in small watersheds, and was originally proposed by the Sichuan Hydraulical Department and has been widely used in small watersheds in Sichuan Province (Zhou et al., 1991; Wu et al., 1993). This equation is complex and involves a group of topographical parameters (as listed in Table 3), which can be measured based on the map and in field, and some rainfall parameters, most of which can be consulted from an official handbook.

Since it is very complex to follow the calculation process, we introduced this equation simply in this manuscript, and the complete calculation process can be followed as:

(1) The rainfall intensity (S) and the attenuation index (n) of rainstorm

Based on the rainstorm contour maps of “The Rainstorm and Flood Calculation Manual of Medium and Small Basins in Sichuan Province”, the maximum 1-hour rainfall ($\overline{H}_1$) and the maximum 6-hour rainfall($\overline{H}_6$) , and their corresponding variation coefficients (C_{V1} and C_{V6}) can be determined (Table 3). Then, the modulus coefficients (K_1 and K_6) for the variation coefficients under different return periods (P) can be obtained from the Pearson Type III Distribution table. The attenuation index (n) of rainstorm under different return periods (P) can be calculated:

$$n = 1 + 1.285(\lg \frac{\overline{H}_1 K_1}{\overline{H}_6 K_6}) \qquad (9)$$

The rainfall intensity (S) of rainstorm is equivalent to the maximum 1-hour rainfall for short duration storm within 24 hours. It can be calculated:

$$S = \overline{H}_1 K_1 \qquad (10)$$

(2) The runoff yield and confluence parameters

The runoff yield parameter (μ) can be calculated:

$$\mu = 3.6 K_P F^{-0.19} \tag{11}$$

Where K_P is the modulus coefficients when the variation coefficient (C_V) is equal to 0.23, it can also be obtained from the Pearson Type III Distribution table.

The runoff confluence parameter (m) can be calculated:

$$m = 0.318 \theta^{0.204} \tag{12}$$

Where θ is the catchment characteristic parameter, it can be calculated:

$$\theta = \frac{L}{J^{1/3} F^{1/4}} \tag{13}$$

Where F is the catchment area; L is the channel length; and J is the longitudinal slope of the channel.

(3) The runoff confluence time (τ) and the runoff coefficient of flood peak (φ)

The runoff confluence time (τ) can be calculated:

$$\tau = \left[\frac{0.383}{m S^{1/4} / \theta} \right]^{\frac{4}{4-n}} \tag{14}$$

The runoff coefficient of flood peak (φ) can be calculated:

$$\varphi = 1 - \frac{\mu}{S} \tau^n \tag{15}$$

(4) The flood peak discharge (Q_B)

The flood peak discharge (Q_B) can be calculated:

$$Q_B = 0.278 \varphi \frac{S}{\tau^n} F \tag{16}$$

(5) The debris flow peak discharge (Q_{max})

The debris flow peak discharge (Q_{max}) can be calculated:

$$Q_{\max} = (1 + \lambda) Q_B D_U \tag{17}$$

Where D_U is the blockage coefficient; λ is the increase coefficient of debris flow peak discharge, it can be calculated:

$$\lambda = C / (1 - C) \tag{18}$$

Where C is the volume concentration of debris flow.

7. English language needs to be revised by a native speaker.

Responds: We have contacted a native speaker to improve the English.