



Interactive
Comment

Interactive comment on “Glacier lake outburst floods of the Guangxieco Lake in 1988 in Tibet, China” by J. J. Liu et al.

J. J. Liu et al.

chouchoujj@163.com

Received and published: 15 February 2014

We have made a thorough revision following the comments and instructions given by the two reviewers. The revisions are as follows:

1) Comments from H. Frey

1. Title: The singular ('flood' instead of 'floods') should be used, as a single event is investigated.

Reply: We accept the comment. And now the title is 'Glacier Lake Outburst Flood of the Guangxieco Lake in 1988 in Tibet, China', with running title as 'GLOF of the Guangxieco Lake'

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



2. P406L2: Is there a scientific study that proves that GLOFs became more frequent in the course of global warming? If so, the respective study should be cited in the text (e.g., in the introduction). Otherwise I suggest avoiding this statement.

Reply: We do not find the related literatures, so we've deleted the statement.

3. P4606L3-4: 'there are few observations of the reasons...' I agree that there are only a few observations of glacier lake outbursts in the meaning that only very few outbursts could have been monitored in real time during an actual outburst. However, the reasons of the outburst are known for many (maybe most?) lake outbursts (see also comment for P4607L6). I thus suggest avoiding or rewording this statement in the abstract.

Reply: Now the statement in the abstract is reworded.

4. P4606L6-7: The fact that Guangxieco Lake is the lowest glacier lake of Tibet that burst out should also be referenced in the text. Anyway I suggest removing this statement from the abstract and only mention it in the introduction or study site description, as it is not relevant enough to be mentioned here.

Reply: This statement is removed from the abstract and is referenced in the introduction. This statement is removed from the abstract and is referenced in the introduction. The comments 2-4 are all related to the abstract. In fact, the abstract is rewritten as follows:

Glacial lake outburst flood in Tibet is studied by a case of the Guangxiecuo Lake outburst in 1988, using geomorphological evidence, interviews of the local inhabitants, archive materials and satellite images. It was found that: 1) There were three main reasons for the GLOF in 1988: intense pre-precipitation and persistent high temperatures before the outburst, ice avalanche by rapid movement of the Gongzo Glacier and low self-stability of the end-moraine dam by perennial piping. 2) The GLOF with the peak discharge of 1270 m³/s was evolved along the Midui Valley following

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



sediment-laden flow – viscous debris flow – non-viscous debris flow – sediment-laden flood. Eventually, the sediment-laden floods blocked the Palongzangbu River. 3) Comparing the conditions for the outburst in 1988 and at present, the possibility of a future outburst is thought to be small unless the glacier moves rapidly again. Reconstruction of GLOF processes and the outburst conditions is helpful for assessing the potential outburst in the glacier lakes in Tibet.

5. P4606L20-21: For me it is confusing to list ‘sediment quantity’, ‘flash floods’, and ‘largescale down-river floods’ in a row here; causes and consequences should be separated. I suggest rewriting.

Reply: This sentence is corrected and the confusing words, such as ‘sediment quantity’, ‘flash floods’, and ‘largescale down-river floods’, are all deleted. Now it is ‘Glacial Lake Outburst Floods (GLOFs) usually carry a quantity of moraines with the characteristics of high peak discharge and long-distance erosion; they may immediately endanger lives, infrastructure and power supply (Carey, 2008; Kaltenborn et al., 2010)’

6. P4606L24: To be in accordance with the other regions listed afterwards, the South American Andes should be mentioned instead of the Cordillera Blanca. Or – even better – would be to mention the specific mountain ranges of the other regions listed as well (in Central Asia, North America, and the Himalayas).

Reply: Now the South American Andes is mentioned instead of the Cordillera Blanca.

7. P4607L6: As mentioned above in the second comment, I do not agree with the statement, that only little is known about the reasons for GLOFs. It maybe applies to the specific region (the Karambar Valley) mentioned by Iturrizaga (2005), but there are many scientific studies of GLOF analyses and reconstructions from all regions in the world where triggers of the outbursts are clearly identified. I suggest removing.

Reply: Now the statement, which may be questionable, is removed.

8. P4607L12: To which region correspond the mentioned 35,000 km² if they account

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



only for a certain fraction of the Qinghai-Tibet Plateau? Please re-write.

Reply: The Tibet Plateau is a part of the Qinghai-Tibet Plateau. And the Tibet Plateau has the glaciers' area of 35,000 km². Now the sentence is:

A large number of glaciers are widely distributed in Tibet Plateau, and the area of glaciers is about 35000 km², which accounts for 75% of the glaciers in the Qinghai-Tibet Plateau (Li et al., 1986).

9. P4607L20: Where does the number of 30 GLOFs in Tibet from 1930-2010 come from? Please cite! (The cited studies were published in 1988 and 1999, i.e. more than 10 years before the end of this period. . .)

Reply: We added the adequate references '(Xu, 1988; Lv et al., 1999; ICIMOD, 2011; Liu et al., 2013)' into text. Now the sentence is:

It is estimated that there were at least 30 GLOFs in Tibet from 1930-2010, but numbers are highly uncertain and likely underreported (Xu, 1988; Lv et al., 1999; ICIMOD, 2011; Liu et al., 2013).

10. P4606: General comment on the structure of the background section: The description of the 1988 event (currently section 2.1) should be moved to after the description of the lake the glacier, and the valley (currently 2.2). It could be placed in the beginning of section 3 (i.e. before the section on the reasons for the GLOF).

Reply: Now the sections are rearranged as follow:

2.1 Study area (past 2.2); 2.2 The GLOF of the Guangxieco Lake on 15 July 1988 (past 2.1)

11. P4608L5: Please give references for the statements that this region has stronger seismic activities, more rainfall, and higher temperatures than the rest of Tibet.

Reply: The reference (CSECAS, 1986) is added into text. Now the sentence is:

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



The Guangxieco Lake lies in Yupu Village of southeastern Tibet (in Fig.1); it has stronger seismic activity, more rainfall, and higher ice temperatures than any other place in Tibet (CSECAS, 1986).

12. P4608L8: Much more details are needed about the influence of the monsoon in this region. Since strong precipitations are mentioned as one factor for this lake outburst and since all Tibetan GLOFs seem to have taken place in a certain period of the year, characteristics of the monsoon are of fundamental importance for analyses of lake outbursts in this region.

Reply: Although the relationships between the GLOFs and monsoon were mentioned by reviewer #1 sometimes. We insist that the GLOFs depend more on the local climate than on the monsoon, and there seems to be no direct evidence for the effect of monsoon, so the monsoon is not taken into account in our discussion.

13. P4608L9: More details about the glacier characteristics should be given as well (e.g. the altitude of the equilibrium line (ELA)) since the cited study is in Chinese.

Reply: The characteristics of the Gongzo glacier, including its ELA, area, altitude,..., are now given in the section 2.1.2 in detail.

The Gongzo Glacier has three branched glaciers and their equilibrium-line altitudes (ELA) run between 4600m and 5000m (Li and You, 1992). It is a typical maritime-temperate glacier at a lower elevation than the other glaciers in China. The eastern branched glacier occupied 6.21 km² above 4300m, and the western branched glacier occupied 11.36 km² and connected to the central glacier. The central glacier's total area was 17.18 km², having a firn basin, an ice fall and an ice snout. The firn basin has circularity chair-like above 4850 m. The ice fall has an altitude from 4100 m to 4850 m, a width of 500 ~ 850 m, a length of 2000m and an ice surface slope of 25°~30°. The ice snout was at an elevation of 3800m ~ 4100 m, length of 3500 m, width of 250 m~ 700 m, maximum thickness of about 70 m and an ice slope of 2°~5°. The supraglacial moraine covering above the ice snout was brown and consisted of

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



angular granite gravels of 3cm ~ 10cm in diameter.

14. P4608L14/15: The wave overtopped the rock dam? According to next sentence (and the rest of the text and the figures), I assume that this lake is dammed by a moraine dam!

Reply: We used the word 'moraine' instead of 'rock'.

15. P4609L13: Which slope is 70–80, the inner or the outer? This value is extremely high for morainic material.

Reply: The left lateral-moraine dam had outer slope of $70^{\circ} \sim 80^{\circ}$. The data was measured in fieldwork in 2007.

16. P4609L21-22: The measured runoff is a single measurement at one day. It is doubtful how well this measurement represents the conditions for the event 19 years ago. For sure this runoff doesn't say anything about the conditions during the event, neither about the condition before the event (i.e. before the breach formed). And neither it is a mean rate of the summer runoff, as stated in the text. Please revise.

Reply: We've deleted the data about the runoff in the original text, because it was measured in 2007 irrelative to the outburst conditions. It was written in the original text to give the readers a more comprehensive understanding of a local region from June to July.

17. General comment on figures of the study area section: I suggest adding a figure with an overview of the study region in the beginning of this section. In the background of the figure, a satellite image or a topographical map could be shown. This would also replace Figure 2 for the description of the glacier, which is not very suitable in the current form. The current Figure 1 (photo of the lake) could either still be a stand-alone figure or part of this new overview figure as well. Locations of the sites for grain size distributions could be indicated as well, and furthermore the photos of Figure 3 could be integrated. Even if Figs 1 and 3 will remain, at least a minimal overview figure is

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



required, including an inset showing the location of the lake and the valley within the larger region.

Reply: Now a satellite image of an overview of the study region, as new Fig.1a, is added into the section 2.1. The configuration of the Midui Gully drainage basin (the past Fig.7) and the past Fig.2 and Fig.3 combined to make a new Fig.1b. We think the new Fig.1 can provide the readers a comprehensive view on the study region.

18. P4611L2-5: More references are needed here. There is a lot of literature on potential triggers for GLOFs, but currently only a non-scientific report is cited.

Reply: Now a scientific reference (Lv, 1999) cited here.

A lake outburst can be triggered by several factors: ice or rock avalanches, the self-destruction of the moraine dams due to the dam slope and seepage from the natural drainage network of the dam, earthquakes or sudden inputs of water into the lake e.g. through heavy rains or drainage from lakes further up-glacier (Lv, 1999; Rai, 2005).

19. P4611L6-7: The event in question took place 25 years ago; the fact that no earthquakes were recorded in the last 20 years is thus useless in this context. Here, only seismic records from the 15 July 1988 (and maybe a few days before) are of interest. Furthermore, a source of this information should be given.

Reply: In this study region, there is no seismic record from 1983. The information is from the China Earthquake Networks Center (CENC), which is website of http://www.csndmc.ac.cn/newweb/catalog_direct_link.htm. Now the sentence is: Regarding the reasons for this event, earthquakes are excluded because there was no earthquake recorded in the last 30 years depends on the data from China Earthquake Networks Center (CENC).

20. P4611L11: I suggest changing the title of this section (e.g., 'climatic observations').

Reply: Now the title of section 3.1 is climatic observations.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



21. P4611L12-13: Only the fact that all recorded GLOFs in Tibet took place in the same four month does not at all suggest a relation to climate change! I rather suggest a relation to the monsoon. As mentioned above, the relation to the monsoon should be further elaborated.

Reply: In our past study, the paper was published on Quaternary International in 2014 proved the relationship between air temperature fluctuation and GLOF in Tibet, China. We still insist that the GLOFs depend more on the local climate than on the monsoon, and there seems to be no direct evidence for the effect of monsoon.

22. P4611L16 and Fig. 4a: Figure 4a rather suggest an increase in precipitation since the 1960s, predominantly from 1960 to 1980. After 1980, the increase is not obvious.

Reply: The past sentence P4611L16 is rewritten clearly now. And an average trend line of precipitation since the 1960s is added into the new Fig.3a to show the increase trend clearly. Now the sentence is rewritten as:

The analysis showed that precipitation has increased continuously since the 1960s, predominantly from 1960 to 1980. But after 1980, the increase is not obvious.

23. P4611L18 and Fig. 4a: In Figure 4a, the precipitation in 1983 appears to be clearly below 1000mm. I thus suggest rewriting this paragraph.

Reply: This is our mistake. Now this paragraph is rewritten:

The analysis showed that precipitation has increased continuously since the 1960s, predominantly from 1960 to 1980. But after 1980, the increase is not obvious. Before the 1988 outburst, there were some wet years with an annual precipitation of more than 1000 mm in 1982, 1985 and 1987. In 1988, the precipitation reached 1152.6 mm, the maximum of the last 50 years (in Fig.3a). On the eve of the outburst, the total precipitation of 451.2 mm from May to July in 1988 had increased by 185.5 mm compared with the same period in the last year (in Fig.3b), and on 4 July, the precipitation reached 65.1 mm, the maximal daily precipitation of that year. Such intense precipitation might

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



promote the glacier accumulation, the ice-snout movement near to the lake, and the water level in the lake.

24. P4611L19-21: These statements are not documented in Fig 4b; to do so, the monthly averages should be plotted as well. Furthermore, it would be useful to also show the temperature and precipitation records for the week before the event in another figure (e.g., 4c).

Reply: The new Fig.4b is redrawn and the sentence P4611L19-21 is rewritten. In the new Fig.4b, the monthly temperature and precipitation of 1987 and 1988 both show to compare the differences clearly. Now the sentence is:

In 1988, the precipitation reached 1152.6 mm, the maximum of the last 50 years (in Fig.3a). On the eve of the outburst, the total precipitation of 451.2 mm from May to July in 1988 had increased by 185.5 mm compared with the same period in the last year

25. P4611L24-25: As long as no climatic monthly average temperatures are given, the statement that July was the hottest month of 1988 is not surprising or exceptional (this applies to large parts of the northern hemisphere).

Reply: Maybe it is not surprising or exceptional, but it is fact, which we think it is important to tell readers.

26. P4611L25-26: Here as well, climatic average values are needed to show, that the 75 days period with average temperatures above 10 oC are exceptional.

Reply: Here, a new Fig.3c (Daily temperature and precipitation of Bomi before outburst in 1988) is added to text to show the daily fluctuation. Now the sentence is:

Combined with the daily temperature, there were 75 continuous days where the average temperature was above 10 °C by five-day moving average after 15 May 1988 (in Fig.3c).

27. P4612L10-14: A figure showing the glacier terminus in the mentioned satellite im-

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



ages would be very illustrative. In particular it would be interesting to have an additional satellite scene shortly before the event, in order to verify the small distance of only 15m to the lake.

Reply: We've tried to find a satellite image of 1987-9-27 before the outburst, but it was covered by large clouds and couldn't show the terminus clearly. So we can only use the data of 15m from the reference Li and You (1992).

28. P4612L6-9 and L15-27: I cannot follow the explanations of the glacier surge and the supposed ice avalanche; an ice avalanche break-off from the tongue seems not be realistic to me. Ice avalanches of temperate glaciers are normally observed at slopes steeper than 25, but the tongue of Gangxieco glacier is described to have a slope of only 2 – 5° (P4610L13). A break-off at such low slope angles is not realistic. Field investigations have been performed in 2007, i.e. 19 years after the event, so evidences for a glacier surge observed in 2007 only proof that this is a glacier that surged in 2007 and therefore potentially performed other surges in earlier years; however, it does not make a direct link to the conditions in 1988. Furthermore the observed ogives and the tensile crevasses (rather use the term crevasses instead of cracks) are not at all a proof for a surge; ogives typically form below ice falls (see Fig. 2), and crevasses are caused by the shape and geometry of the glacier bed rather than changes in velocity. The reported front variations as observed in the satellite images listed in Table 4 hint to a glacier surge, which of course would have increased the water level and the pressures on the moraine dam. However, a surge does not explain the retreat of more than 600m within only a few months as suggested in P4612L10-14. Please revise this section and add supporting figures and text.

Reply: The slope of ice snout was measured to be 2°-5° in fieldwork in 2007. It was not the slope in the outburst year.

And we added a new Fig.4 (Area variations of the Guangxieco Lake in different periods) in order to show the possibilities of ice avalanches. In this figure, you can see a clear

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



change in the lake outline. And the same time, combining with some field observations and references, we think rapid movement of the Gongzo Glacier is one of outburst reasons.

29. P4614L11-16: How can perennial piping been inferred from a topographical map? Please show the topographic map of 1980 in a figure and give more details on the local interviews from 1990.

Reply: It is difficult to reconstruct an outburst before 26 years as the reviewer #1 said. The phenomenon of perennial piping has not been inferred from a topographical map of 1980, but it has been shown in Li and You (1992), as we cited in text.

30. P4614L22-P4615L8 and Fig. 6: All the findings presented in this section are based on other studies. Since these studies (Lv et al., 1999 and Li and You, 1992) are only available in Chinese, more details should be given here, in order that all involved reconstructions can be followed without knowing the cited studies. For instance, it is not clear to me: (i) how the volume of the ice avalanche has been inferred (as mentioned above, I have strong doubts about the ice avalanche hypothesis); (ii) how the peak discharge (and its timing) was calculated; (iii) how the discharge after the peak discharge has been inferred; and (iv) how the lake volume before and after the event (and hence the outburst volume) has been reconstructed.

Reply: The calculation of the volume of ice avalanche and discharge after peak discharge were both directly cited from the results in Lv et al (1999). In the references, the calculation method has not mentioned. We've asked the authors but received no response yet.

The method of peak-discharge calculation was added into the text, as the formula1. The calculated result agrees with the previous surveys (Lv et al., 1999).

$$Q_{\max} = 1.165(L/B)^{1/10}(B/b)^{1/3}b(H-h)^{3/2} \quad (1)$$

And we rewrote the section 4.1 to explain how the lake volume before and after the

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



event (and hence the outburst volume) has been reconstructed. A paragraph is added into text as follow: With the lack of the images (e.g. winter of 1987 or spring of 1988) before the outburst, the lake of 1988 was higher than it of 2007 to be 17.4 m depend on the fieldwork in 2007. Assuming the boundary of glacier of 1988 was consistent with it of 1990 and combining with the Digital Elevation Model (DEM) of 1980, the area and volume of lake before the outburst were calculated to be $6.4 \times 10^5 \text{ m}^2$ and $69 \times 10^5 \text{ m}^3$, respectively. By the TM image (27 October 1988), the area and volume of lake after outburst were calculated to be $2.3 \times 10^5 \text{ m}^2$ and $9.7 \times 10^5 \text{ m}^3$, respectively. And it was found that the region of glacier in 1980 was covered partly by the lake after outburst in 1988, and the region of glacier was rapidly disappeared. It also shows that large areas of glacier possibly collapsed into the lake before the outburst in 1988.

31. P4615L10-P4616L16 and Fig. 7: An figure showing not only the locations of MD1–MD5, but also a map of the observed depositions would be helpful to interpret the evolution of the flow characteristics.

Reply: In new Table.2, the density of flow in different cross section was added. We think it is helpful to interpret the evolution of the flow characteristics.

32. P4615L22-P4616L16: In general: I assume that these samples have been taken during the field mission in 2007. Is it certain that all observed depositions originate from the 1988 outburst? Or could it be that other (maybe smaller) outbursts happened after 1988? Or that some of the sediments were deposited after the 1988 event by the river, e.g. during periods with heavy rainfall and thus high discharge?

Reply: In the study region, there is no large-scale flood after 1988 (Yang et al., 2012). And the samples have been taken at 0.5 m below ground surface. Moreover, they are obviously different from the sedimentary material of perennial flow in the study area. So we think the five samples originated from the 1988 outburst, of course, with more or less alteration due to water erosion after the event.

33. P4616L20-22 and Table 4: As mentioned above, a figure showing the satellite

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



images listed in Table 4 would help to illustrate the lake evolution. How have the lake volumes been estimated? Please give the used formula and its source.

Reply: Combining with the Digital Elevation Model (DEM) of 1980 and the satellite images in different periods, the lake volumes have been estimated. The method you can see in the reply for question 30.

34. P4616L22-24: To which volume refer the numbers of 36.6% and 16.2%? Please reword.

Reply: We rewrite the sentence. Now it is 'In new Table.3, the area and water storage of the glacial lake in 2010 was only 36.6% and 16.2% of the lake before outburst in 1988, respectively.'

35. P4617L9-10: As mentioned above (P4606L6-7), this statement needs a reference.

Reply: Yes, we gave the reference (Xu, 1988; Lv et al., 1999; ICIMOD, 2011; Liu et al., 2013).

36. P4617L20-24: Again, showing the mentioned satellite imagery should support this. In particular it would be interesting to see an image from shortly before the event in 1988, to verify the glacier advance to 15m before the lake as stated by Li and You (1992). In P4607L25 it is mentioned that Yang et al. (2012) used satellite images from before and after the outburst. The explanation of the ice avalanche is still not convincing to me.

Reply: Now we give a new Fig.4 and new explanations in section 3.2. Maybe it is helpful to persuade the reviewer #1.

TECHNICAL CORRECTIONS:

37. P4606L14-15: Add spaces before and after the dashes (as done on P4618L7)

Reply: Yes, the spaces are added.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



38. P4607L3: Remove one 'W' of WWantanbe.

Reply: Yes, it is corrected.

39. P4607L11: To me, 'widely distributed' seems not to be an appropriate expression for describing the glacier coverage.

Reply: Ok, the word 'distributed' instead of 'widely distributed'.

40. P4607L13: Replace 'With climate changes' (e.g., by 'with climate change' or similar)

Reply: Ok, it is corrected.

41. P4607L26: Insert 'the' between 'after' and 'outburst'.

Reply: Ok, it is corrected.

42. P4608L17: Replace 'mainstream' by 'main river'.

Reply: Ok, it is corrected.

43. P4609L10: Rephrase sentence. (e.g., begin with 'Figure 1 shows that'; and replace 'two-grade').

Reply: Ok, it is corrected.

44. P4610L4-8 and Fig. 2: I suggest using the expressions 'the western, a central, and an eastern branch' throughout the text, also in Figure 2.

Reply: Ok, it is corrected.

45. P4610L24-25: I think this sentence should be written in present: 'There 'are' three Tibetan villages [...] which 'have' approximately [...]'. (Or were they destroyed during the event?)

Reply: Ok, it is corrected.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

46. P4613L8-10: Please mention in the text that the location of the sampling sites is given in Fig. 7.

Reply: Ok, it is corrected.

47. P4611L22-23: I do not understand the term 'pre-accumulation'. Do you mean 'accumulation'? Please reword.

Reply: The word 'pre-accumulation' means accumulation before outburst. But we use the 'accumulation' to instead of 'pre-accumulation'.

48. P4612L4: Please reword the sentence; the phrase 'the necessary conditions of climatic background' has no meaning.

Reply: Ok, it is corrected.

49. P4613L4: Replace 'outside' by 'external'.

Reply: Ok, it is corrected.

50. P4613L8-10: This is confusing: in the previous sentence it is stated that this is the lowest outburst lake of Tibet, but here the high altitude is mentioned. And from the context of the cited references it seems that already several studies exist that deal with the causes and involved processes of this lake outburst. Please revise.

Reply: Ok, it is corrected.

51. P4615L17: Mention that locations of MD1 to MD5 are shown in Fig. 7.

Reply: Ok, it is corrected.

53. P4618L2: The last sentence of point 3 is not understandable to me. Please revise. Tables 1 and 2: I suggest merging the two tables into one, identical to Table 2 in Liu et al. (2013). Or skip Table 1 completely, the information of Table 1 (elevations and coordinates of the sampling sites) are not that important as long as the locations of the sites are indicated in a figure (currently in Fig. 7).

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



Reply: The last sentence of point 3 and Table 1 were both deleted.

54. Figures 1-3: As mentioned above, I suggest to make a new overview figure based on a satellite image or the topographical map. Figures 1 to 3 could be replaced, or the photos could be included as insets in this new overview figure.

Reply: Ok, it is corrected.

55. Figure 4: As mentioned above, climatic averages should be included into Fig 4b, and a new figure (4c) showing the temperatures and precipitation of the week before the lake outburst in 1988 would be very helpful and should be added.

Reply: Ok, it is corrected.

56. Figure 6: As for the explanations in the text (P4614L22-P4615L8), it is not clear how this hydrograph has been inferred. And I assume it is taken from another study, so please mention the source in the figure caption.

Reply: Ok, it is corrected. Now it is 'Fig.7. Time-discharge curve of Guangxi Lake Outburst (the data is from Li and You, 1992)'

2) Comments from Anonymous Referee #2

1. The whole pages: The discussion requires photos, schematic figures, graphs, tables and equations. The discussion is too simple, because there are no schematic figures or equations. Schematic figures and equations are also important for the discussion.

Reply: Some schematic figures (Fig.4, Fig.6 and Fig.8) and equations (1, 2, 3) all were added into text.

2. Page 4614 to 4616: There are no figures of the longitudinal and the cross sectional profiles of the Midui valley. The discussion of discharge requires the profiles of the Midui valley.

Reply: A new Fig.8 (The cross sectional profiles from section MD1 to section MD5)

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



were added into text to help for discussion of discharge.

3. Page 4615: The method of the estimate of peak discharge is not described. What equation is used for the estimate of peak discharge?

Reply: The equation 1 was added into text to explain how to estimate the peak discharge.

$$Q_{\max} = 1.165(L/B)^{1/10}(B/b)^{1/3}b(H-h)^{3/2} \quad (1)$$

where L is the length of lake, B is the maximum width of breach, b is the average width of breach, H is the maximum depth of lake, h is the height of residual dam. All the parameters were obtained by field surveys.

4. Fig. 6: The method of the estimate of time variation in discharge is not described. How do the authors determine time variation in discharge?

Reply: The calculation of the volume of ice avalanche and discharge after peak discharge were both directly cited from the results in Lv et al (1999). In the references, the calculation method has not mentioned. We've asked the authors but received no response yet.

5. Page 4615 to 4616: The authors discuss the change in flood types along the Midui valley. This is important, because the result is also described in Abstract and Conclusions. However the definition of the flood types is not explained in detail. The definition of sediment-laden flow, non-viscous debris flow, and viscous debris flow should be described.

Reply: we gave the definition of sediment-laden flow, non-viscous debris flow, and viscous debris flow in new section 4.2. Traditionally, we distinguish the flow types mainly by their density (e.g., Fei and Su, 2005). Now the sentence is rewritten as:

Fei and Su (2005) defined the flood types using its density, e.g. the flood with density less than $1.4 \times 10^3 \text{ m}^3$ is the sediment-laden flow, the flood with density more than

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



$1.8 \times 10^3 \text{ m}^3$ is the viscous debris flow and the flood with density between above two is the non-viscous debris flow.

6. Page 4615 to 4616: The discussion of the flood types requires the information of sediment concentration and sediment particle size in flow. However the authors describe sediment particle size only and do not describe sediment concentration. The discussion of sediment concentration is needed.

Reply: We've developed a new method to estimate the flow density by the particle size distribution (Li et al., 2013). The sediment concentration is also related to the original particle size distribution according to our investigations of thousands of debris flows. Then we added in the text:

A density calculation for samples depends on grain size distribution (Li et al., 2013) was used here to estimate the density of flow in different section.

$$P(D) = CD - \mu \exp(-D/D_c) \quad (2)$$

$$= k \exp(-2.28\mu) + 0.48D_c^{0.25} \quad (3)$$

where $P(D)$ is the percentage of grains $> D$ (mm), μ is a power exponent, D_c is the characteristic size, μ is the density of flow (g/cm^3) and k is correction coefficient depend on the ages and exposure of samples. And in this study, the coefficient k is 0.75 and the density of flow is calculated in new Table.2.

7. Fig. 8: Is the horizontal axis in log scale or in different scale? Its explanation is needed.

Reply: In Fig.8, the explanation of 'The horizontal axis is in log scale' was added.

We also have made a complete revision both of the organization and expression. We hope the revision will be satisfactory for your approval.

Sincerely yours, Jing-Jing Liu, Zun-Lan Cheng, and Yong Li

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



Interactive
Comment

Full Screen / Esc

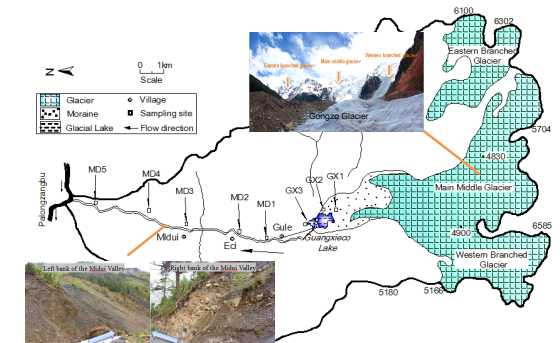
Printer-friendly Version

Interactive Discussion

Discussion Paper



a. TM image of 2005-9-8



b. Configuration of the Midui Gully drainage basin and the all sites of soil samplings

(GZ 1-3 and MD 1-5) (Landform is modified from Cui et al., 2010, Fig.4)

Fig. 1. Landscape and background of the study area

Fig. 1. Landscape and background of the study area



Fig.2. The photo of the Guangxieco Lake in 2007

Fig. 2. The photo of the Guangxieco Lake in 2007

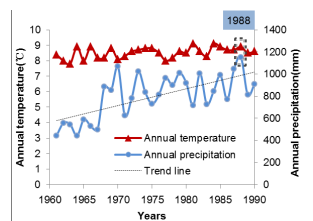
Full Screen / Esc

Printer-friendly Version

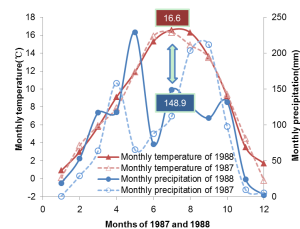
Interactive Discussion

Discussion Paper

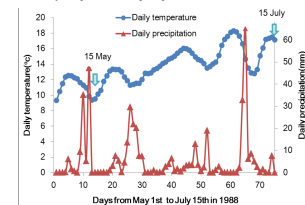




a. Annual temperature and precipitation of Bomi from 1960-1990



b. Monthly temperature and precipitation of Bomi in 1987 and 1988



c. Daily temperature and precipitation of Bomi before outbreak in 1988

Fig.3. The temperature and precipitation of Bomi station

Fig. 3. The temperature and precipitation of Bomi station

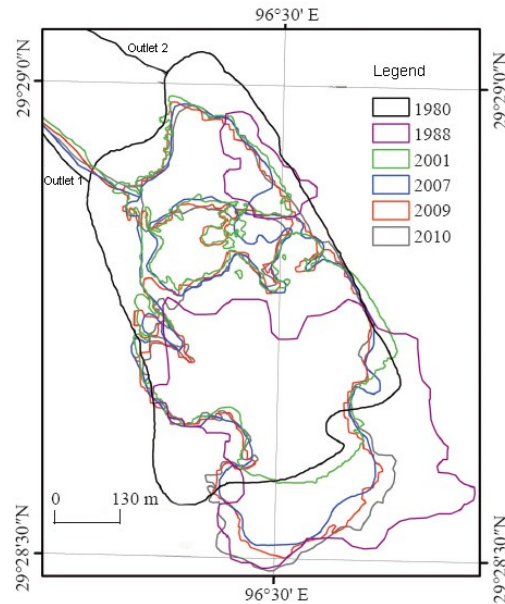


Fig. 4. Area variations of the Guangxieco Lake in different periods (It is modified from Yang et al., 2012, Fig.5)

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

Fig. 4. Area variations of the Guangxieco Lake in different periods (It is modified from Yang et al., 2012, Fig.5)



Fig.5. The ogives in the Gongzo Glacier (Photo was taken by Lizhen) (Xie and Liu, 2010)

Fig. 5. The ogives in the Gongzo Glacier (Photo was taken by Lizhen) (Xie and Liu, 2010)

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



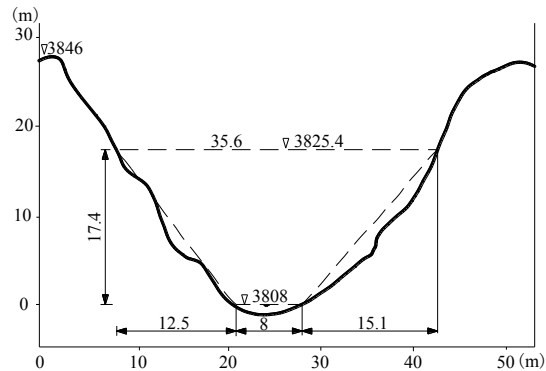


Fig.6. The cross sectional profile of breach in the Guangxieco Lake

Fig. 6. The cross sectional profile of breach in the Guangxieco Lake

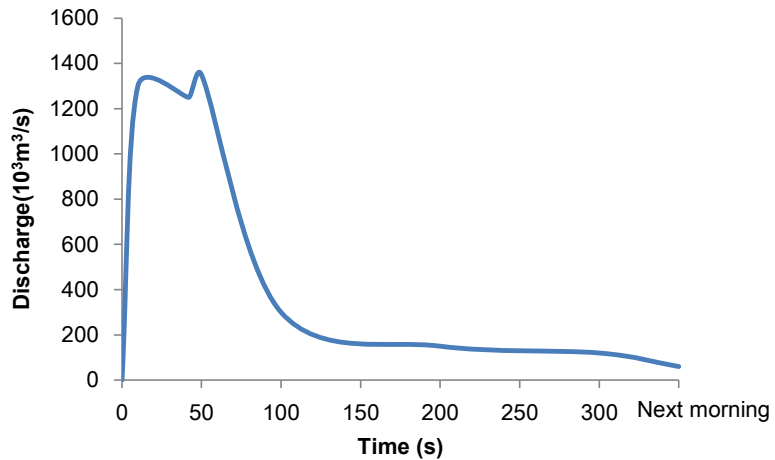
[Interactive
Comment](#)

Fig.7. Time-discharge curve of Guangxieco Lake Outburst (the data is from Li and You, 1992)

Fig. 7. Time-discharge curve of Guangxieco Lake Outburst (the data is from Li and You, 1992)

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

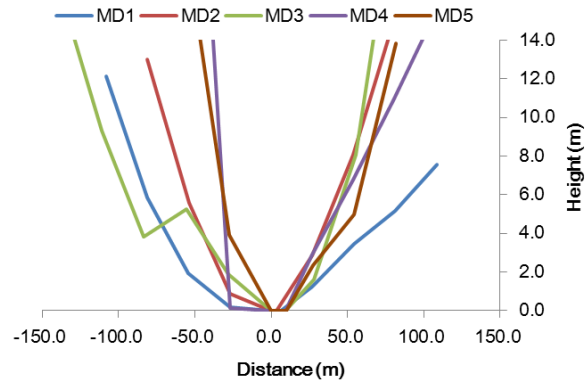


Fig 8 The cross sectional profiles from section MD1 to section MD5

Fig. 8. The cross sectional profiles from section MD1 to section MD5

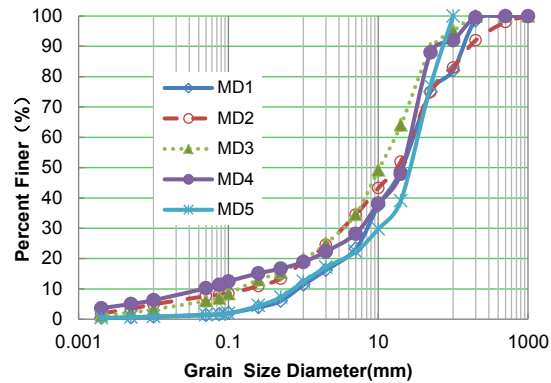


Fig.9. The particle-size distribution of soil samples of Midui Valley (The horizontal axis is in log scale)

Fig. 9. The particle-size distribution of soil samples of Midui Valley (The horizontal axis is in log scale)

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

Table 1. The grain size distribution of moraines and possible types of seepage failure (Liu et al., 2013)

Sampling No.	Grain size(mm)						C_u	C_c	$D_d(\text{mm})$	Gradation	The type of seepage failure
	d_{20}	d_{30}	d_{50}	d_{10}	d_5	d_3					
GX1	6.5	1.5	0.7	0.18	0.08	0.02	36.1	1.92	0.274	Well-graded	Transition type between the two
GX2	6	1.2	0.4	0.15	0.08	0.06	40	1.6	0.159	Well-graded	
GX3	28	6	2.5	0.3	0.1	0.05	93.3	4.29	1.10	Poorly-graded	Soil flow Piping

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

Fig. 10. Table 1. The grain size distribution of moraines and possible types of seepage failure (Liu et al., 2013)

Table 2. Five soil-sampling sites in Midui Valley

Sampling Number	Altitude(m)	Latitude N	Longitude E	Height of flood-mark section(m)	Clay Content (%)	Gradient (%)	μ	D_c	Density ($10^3/\text{m}^3$)
MD1	3765	29°28.93'	96°29.59'	4.7	0.56	4.52	0.014	6.17	1.48
MD2	3748	29°29.38'	96°29.65'	6	3.44	7.21	0.031	27.03	1.79
MD3	3723	29°30.33'	96°29.74'	6	2.26	1.80	0.029	25.54	1.78
MD4	3714	29°31.02'	96°29.97'	5.7	5.04	0.68	0.020	35.32	1.89
MD5	3634	29°32.05'	96°30.04'	4.5	0.65	4.17	0.011	6.34	1.49

Fig. 11. Table 2. Five soil-sampling sites in Midui Valley

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



Table 3. The parameters of the Guangxieco Lake in 1980, 1988, 2001, 2007, 2009 and 2010

Time	Area of lake (10^4m^2)	Water Storage (10^4m^3)	The distance of ice snout to glacier lake (m)	Data source
1980	31.24	535.50	547	Topographic map(1980-10)
1988 (before outburst)	64.00	699.00	15	Li and You(1992)
1988 (after outburst)	22.84	97.17	649	TM(1988-10-27)
2001	20.47	88.53	847	ETM(2001-10-23)
2007	22.14	104.69	780	ALOS(2007-12-23)
2009	22.53	106.76	890	ALOS(2009-11-12)
2010	23.43	113.08	930	ALOS(2010-12-23)

Fig. 12. Table 3. The parameters of the Guangxieco Lake in 1980, 1988, 2001, 2007, 2009 and 2010[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)