

Dear Editor and Reviewers,

The manuscript entitled “Understanding the effects of climate warming on streamflow and active groundwater storage in an alpine catchment, upper Lhasa River” has been thoroughly revised according to the anonymous reviewers’ comments. Major revisions have been made for improving its quality. For example, we have elaborated in detail the mechanism of hydrological processes. Figure 3 was re-draw according to the real situations of topography and distribution of glaciers and permafrost in the Yangbajain catchment according to the reviewer’s suggestions. And we added the GRACE as well as NDVI data to verify our estimations in this study to provide an evidence for the estimated increasing water storage.

For any further corrections and requirements, the authors are ready here for your critiques.

Correspondence and phone calls about the paper should be directed to Prof. Liu Jintao at the following address, phone and fax number, and e-mail address: State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Hohai University; Adress: 1 Xikang Road, Nanjing 210098, People’s Republic of China; Tel: +86-25-83787803; Fax: +86-025-83786606; E-mail: [jtliu@hhu.edu.cn](mailto:jtliu@hhu.edu.cn).

Thanks very much for your attentions to our paper again .

Sincerely yours,

Liu Jintao

**Editor Decision: Publish subject to revisions (further review by editor and referees)** (08 Nov 2019) by Fuqiang Tian

Comments to the Author:

Dear Authors,

I got the comments from two Referees. I understand the field experimental data in Tibetan Plateau is really rare and valuable. I suggest the authors to address the following comments (repeated from the reviewer's comment):

**Response:** Many thanks for your kindly helps. We have address all the following comments.

1) To elaborate the mechanisms of hydrological processes, hydrological cycle and the relations between recharge and drainage in alpine region.

**Response:** We elaborated in detail this issue again and added many newly studies to try to explain it clearly. See details in **Revised Lines [59-61, 70-77]**.

2) To elaborate the main source of streamflow.

**Response:** According to your suggestions, we have added all of them to elaborate it fully and clearly. First, according to our data and the results of Investigation of River and Lake (by Guan et al., 1984) in the first Tibetan Plateau Scientific Expedition and Research, the runoff is mainly recharged by rainfall. For instance, the catchment has a summer (June-August) monsoon with 73% of the yearly precipitation, summer streamflow recharged mainly by monsoon rainfall and meltwater accounts for approximately 63% of the yearly streamflow. According to Guan et al.'s results, 48% of total runoff is fed by rainfall. Revised Lines [157-157, 342-346]

Then we revealed that air temperature acts as a primary factor for the increased streamflow as well as the baseflow through gray relational analysis. **Revised Lines [261-265]**. Furthermore, through parallel comparisons with other sub-basins in the Lhasa River Basin we can indirectly reveal that the increased streamflow at the Yangbajain station is mainly fed by the accelerated glacier retreat.

However, without applications of hydrologic models and hydrological isotopes, the accurate number or ratio to quantify the contribution of glaciers meltwater and permafrost degradation to streamflow have not been provide in this study, and we suggested to do it in future study in the final part of conclusions **Lines [405-409]**.

3) Revise Figure 3.

**Response:** it has been revised accordingly.

4) Try to use more data in this paper in available.

**Response:** it has been added accordingly.

Suggestions for revision or reasons for rejection (will be published if the paper is accepted for final publication)

Journal: HESS

Title: Quantifying streamflow and active groundwater storage in response to climate warming in an alpine catchment, upper Lhasa River

MS No.:HESS\_2019\_302

I have gone through the article several times trying to establish how it can be salvaged as the research done is significant and scientific. However, the authors still did not fully address the issues pointed out by the reviewers.

**Response:** Many thanks for your kindly helps. We have fully addressed your concerned issues in the revised version. In the following, point-to-point responses will be given.

1.The comment "the mechanism of hydrological process, hydrological cycle and the relationship between recharge and drainage of water in alpine region are not described in detail" Unfortunately, the authors did not address this key issue. The mechanism of hydrological process, hydrological cycle and the relationship between recharge and drainage of water in alpine region is the theoretical basis. So authors MUST add it.

**Response:** thank you for your kindly reminders. We elaborated in detail this issue again and added many newly studies to try to explain it clearly. See details in **Revised Lines [59-61, 70-77]**.

2.Figure 3, the color is not clear, especially Glacier and Active groundwater layer, spring and swamps and permafrost. Are the names of the Active groundwater layer and unconsolidated soil layer right? This is can be done by Wang et al. (2018). Wang, W., Wu, T., Zhao, L., Li, R., Zhu, X., Wang, W., ... & Hao, J. (2018). Exploring the ground ice recharge near permafrost table on the central Qinghai-Tibet Plateau using chemical and isotopic data. Journal of Hydrology, 560, 220-229.

**Response:** Thank you very much for your suggestions. According to your suggestions, we have made corresponding modifications by considering local real situations in the study area. We deleted the unconsolidated soil layer and changed "Active groundwater layer" to "Active layer" by referring to the papers of Wang et al. (2018) and Li et al. (2018).

3.The comment "This work has been found that the increased streamflow is mainly fed by the accelerated glacier retreat due to climate warming. There are many factors for the increase of streamflow. The accelerated glacier is just one of all factors. For example, the increase of precipitation, the degradation of frozen soil, the melting of underground ice, and the supply of supra-permafrost water. So I suggest that authors first figure out what is the main sources of streamflow in the study area? Then analyzed the contribution of the recharge sources to runoff based on the variation of all factors under the climate warming. Finally, the main reason for the increase for runoff is obtained." Unfortunately, the authors did not address this key issue. This issue is critical, especially for this study. So authors MUST add it.

**Response:** yes, we have ignored these important issues in the ms. According to your suggestions, we have added all of them to elaborate it fully and clearly. First, according to our data and the results of Investigation of River and Lake (by Guan et al., 1984) in

the First Tibetan Plateau Scientific Expedition and Research, the runoff is mainly recharged by rainfall. For instance, the catchment has a summer (June-August) monsoon with 73% of the yearly precipitation, summer streamflow recharged mainly by monsoon rainfall and meltwater accounts for approximately 63% of the yearly streamflow. According to Guan et al.'s results, 48% of total runoff is fed by rainfall.

**Revised Lines [157-157, 342-346]**

Then we revealed that air temperature acts as a primary factor for the increased streamflow as well as the baseflow through gray relational analysis. **Revised Lines [261-265]**. Furthermore, through parallel comparisons with other sub-basins in the Lhasa River Basin we can indirectly reveal that the increased streamflow at the Yangbajain station is mainly fed by the accelerated glacier retreat.

However, without applications of hydrologic models and hydrological isotopes, the accurate number or ratio to quantify the contribution of glaciers meltwater and permafrost degradation to streamflow have not been provide in this study, and we suggested to do it in future study in the final part of conclusions **Lines [405-409]**.

4.I think the authors may need more data to support their arguments and the discussion needs to be strengthened.

**Response:** In the revised ms, the GRACE as well as the NDVI data were used to verify our estimations in this study. In addition, we know that groundwater level is rising through recent field investigations. However, we don't have continuous data of groundwater stages. So the increases of surface water and shallow groundwater are changing the land cover and NDVI (Figure 10) is rising accordingly in recent years. All these provide evidences to the estimated rising groundwater storage. Many parts of results and discussions have been revised. See in **Revised Lines [318-322; 342-346; 352-354]**.

**References:**

- Guan, Z. H., Chen, C. Y., Kuang, Y. X., Fan Y. Q., Zhang, Y. S., and Chen, Z. M. et al.: Rivers and Lakes in Tibetan. Rivers and lakes in Tibet. Beijing: Science and Technology Press, 1984 (in Chinese).
- Li, Z. J., Li, Z. X., Song, L. L., Ma, J. Z., and Song Y.: Environment significance and hydrochemical characteristics of suprapermafrost water in the source region of the Yangtze River, Science of the Total Environment, 644, 1141-1151, 2018.
- Wang, W. F., Wu, T. H., Zhao, L., Li R., Zhu X. F., Wang, W. R., Yang, S. H., Qin, Y. H., and Hao, J. M.: Exploring the ground ice recharge near permafrost table on the central Qinghai-Tibet Plateau using chemical and isotopic data, Journal of Hydrology, 560, 220-229, 2018.
- Wang, Y. H., Yang, H. B., Gao, B., Wang, T. H., Qin, Y., and Yang, D. W.: Frozen ground degradation may reduce future runoff in the headwaters of an inland river on the northeastern Tibetan Plateau, Journal of Hydrology, 564, 1153-1164, 2018.