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Biogeosciences Discussions

Interactive comment on "Reviews and syntheses: How do abiotic and biotic processes respond to climatic variations at the Nam Co catchment (Tibetan Plateau)?" *by* Sten Anslan et al.

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We highly appreciated the critical but extremely constructive reviewer comments and their thoughtful suggestions. Based on these comments we carefully revised our manuscript. Below you will find our point-by-point response to the reviewer's comments and suggestions.

In the name of all co-authors,

Johannes Buckel and Felix Nieberding

Reviewer 1 (Prof. Dr. Georg Miehe):

Comment 1:

P2 L7: "Why the NamCo should be a model system? Model for what? The lake is one of the three large lakes of the TP and like Yamco Yumco and Qinghai Lake, the lake had a drainage in humid phases - unlike most of the lakes west of the NC"

Author's response: According to Li et al. (1981) and Zhu et al. (2002) the last humid phase, when lake levels of Nam Co were high enough (approx. up to 105-120 m higher than today) to overflow towards Siling Co (or Big Qiangtang lake) ended between 40 and 25 ka BP. This is well before the timeframe of the studies included in our review. As we are focusing on more recent studies, the Nam Co catchment can be used as a case study where many processes happening in larger and/or other areas may be observed on a local level.

Author's changes in manuscript: We removed the word "model" and restructured the corresponding sentences throughout the manuscript to avoid misunderstanding of this term.

On P2 L29 we added the sentence: "Large proportions of the inner TP are endorheic and therefore do not drain into the large river systems."

Furthermore, we included the following paragraph in chapter 3.1 to discuss the existence of a possible outflow of Nam Co: "There are at least seven different levels of continuous terraces around Nam Co, with the highest being over 30 meters above current lake level, corresponding well with the elevation of the natural spillway in the northeast of Nam Co. Several authors claim the existence of a much larger fluvial lake system called "Old Qiangtang Lake", which covered an area of about 30,000–50,000 km2 or more (Li et al., 1981; Zhu et al., 2002). The connections provided by a large lake allowed the gene flow between drainages, which is reflected, for example, by the closely related clades of schizothoracine fish (Cyprinidae, Osteichthyes) from Nam Co and the surrounding lakes, compared with more distant parts of the TP (He et al., 2016). In contrast, due to a vector-mediated passive dispersal across large areas,

other aquatic taxa, such as freshwater snails, seem to have been less influenced by drainage histories (Oheimb et al., 2011). Higher lake terraces are older, suggesting a long-term reduction in lake level (Zhu et al., 2002). This may be associated with an evolution from wet to dry phase, which Li et al. (1981) connects to the gradual uplift of the plateau from early Pleistocene to the Holocene. However, there is an alternative suggestion to this interpretation of a rather modern uplift proposed by Renner (2016) who states that large parts of the TP had already reached average heights of 4,000 m and more during the mid-Eocene ($\sim$40 Ma ago). Recent findings of palm leave fossils on the central part of the TP, dated to ca. 25.5 $\pm$ 0.5 million years, do not suggest a presence of such a high plateau before the Neogene (Su et al., 2019). Thus, although it is suggested that the final large lake phase took place during ca. 40-25 cal ka BP (Lehmkuhl et al., 2002; Zhu et al., 2002), the complex relationship between evolution of the TP and the development and the temporal existence of "Old Qiangtang Lake" are not completely resolved."

Comment 2:

P2 L24: "sorry: it is indeed annoying, but the citation sources could be necessary. Take care: Who first published "Third Pole"?"

Author′s response: To highlight the overall cold temperatures and the occurrence of the third largest ice-mass on earth (after the Arctic and Antarctic), the Tibetan Plateau is also called "The Third Pole". This is common language rather than someone′s intellectual property and thus it is not possible, nor necessary, to quote a person or group of persons as source.

Author′s changes in manuscript: No changes were made in accordance to this comment.

Comment 3:

P2 L24: "the fact that this is often cited does not rise necessarily the value of this state-

ment: could you please check the precipitation and hydrology data of the headwaters! the rivers get their main water in the outer slopes and NOT from the plateau.)PH D Hofer, Bern"

Author′s response: In our study, the Tibetan Plateau is defined as the geographical region including "the entire southwestern Chinese provinces of Tibet and Qinghai, parts of Gansu, Yunnan, Sichuan and neighboring countries" (P2 L25 f.). To highlight the role of the outer slopes to provide freshwater, we modified the sentence.

Author′s changes in manuscript: On P2 L27 now says: "The southern and eastern TP and the adjacent Himalaya regions form the headwaters of several major rivers [. . .]"

Comment 4:

P2 L28: "please check the source of the Ganges"

Author′s response: Most of the tributaries to the Ganges originate in the Himalayas. The author′s response and changes in manuscript to the comment 3 also apply to this comment.

Author′s changes in manuscript: Regarding the source of the Ganges, please see Author′s changes concerning comment no. 3. Furthermore, we omitted to quote the "Amudarya" as it originates from the western TP, which is not anymore in compliance with the changes made above.

Comment 5:

P2 L28: "add "River""

Author′s response: Thanks for your suggestion.

Author′s changes in manuscript: We added "River" so now it says "Yellow River".

Comment 6:

P3 L11: "this is not a helpful generalization; probably not true for the eastern TP. Could

you add sources for this”

Author′s response: Thank you very much for your hint. We agree with your concern and deleted this generalization as the eastern and central TP is modified and managed by humans for the past several thousands of years (see chapter 3.3).

Author′s changes in manuscript: We deleted: “and still relatively little human impact” on P3 L10 f..

Comment 7:

P3 L14: “currently. Please include Li et al. Proceed. Int. Symp. QTP Beijing, Vol 2”

Author′s response: Thank you very much for the suggestion. This adds to the comment 1 regarding the possible outflow of Nam Co towards Siling Co. We agree and restructured the sentence. We also refer to the inserted sentences in chapter 3.1.

Author′s changes in manuscript: The sentence now reads: “Currently, Lake Nam Co represents an endorheic system, acting as a sink for water, sediment and carbon fluxes. The existence of a former drainage (“Old Qiangtang Lake”) towards the northwestern Siling Co and further east, down from the TP is still under discussion (Li et al., 1981, Kong et al., 2011) (see chapter 3.1).”

Comment 8:

P5 L6: “is the weather station in the lake a small island ?”

Author′s response: Yes, there are two small islands in that area of the lake. One was equipped with an Automatic Weather Station (AWS) for approximately two years. Data collected by this AWS has not yet been published but the mean annual precipitation (see Fig. 4) was calculated and communicated orally by Dr. Binbin Wang, Institute of Tibetan Plateau Research, Beijing, who is in charge of the AWS.

Author′s changes in manuscript: No changes have been made in accordance to this comment.

Comment 9:

P5 L13: “What is the scientific value of the MAT ? ! Please check Körner Alpine Plant Life and Körner Alpine Treelines”

Author′s response: Mean annual air temperature (MAT) and mean annual precipitation (MAP) provide an overview about general climatic conditions at Nam Co. They provide a first glance if, for example, there is permafrost to be expected, or which type of vegetation can be anticipated. We agree, however, that these basic statistics do not provide a complete overview, especially as seasonality on the TP is high. We included a table (Table 1) with monthly mean, minimum and maximum air temperatures as well as monthly mean precipitation, averaged from 2006 to 2017, using meteorological data from NAMORS. The dataset was provided by the Institute of Tibetan Plateau Research and the calculations were performed by Felix Nieberding using the tidyverse package family in R on RStudio environment (Wickham, 2017; RStudio Team, 2018; R Core Team, 2019).

Author′s changes in manuscript: We added Table 1 which provides an overview of meteorological parameters throughout the year and cite Ma et al. (2009) for the equipment and maintenance of the sensors. Furthermore, the mean annual temperature and precipitation values in the text were changed to correctly display the values calculated directly from the dataset.

Comment 10:

P5 L14: “please include data about the shifts of the monsoon onset - most important for the ecosystem!”

Author′s response: Depending on the location on the TP, strong interannual variability in onset and strength of monsoonal precipitation can be observed. To highlight the importance of precipitation for pasture greening, we included additional information in chapter 2.1.

Author′s changes in manuscript: In chapter 2.1 we added the sentence: “The onset and strength of monsoonal precipitation varies substantially between individual years and can be delayed by up to six weeks, depending on altitude and latitude on the TP (Miehe et al., 2019).”

Comment 11:

P9 L5: “this refers to Miehe et al. xxx”

Author′s response: We agree, thanks for your comment!

Author′s changes in manuscript: We added the corresponding citation: (Miehe et al., 2019)

Comment 12:

P9 L5: “You follow the Chinese claffification which is not in accordance to international standards. The fact that most publications use "Meadow" does not mean too much. According to the UNESCO Classification "meadow" is a mowed artifical grassland. Better to use "pasture"” Author′s response: Thank you very much for your advice! We agree, because the grasslands on the TP are primarily used for grazing by domestic animals such as yak, sheep and goat.

Author′s changes in manuscript: Throughout the whole document, we replaced “meadow” by “pasture”.

Comment 13:

P9 L14: “please correct according to Noelling !”

Author′s response: We agree and added the corresponding citation.

Author′s changes in manuscript: We added the citation (Nölling, 2006) at P9 L11 in the text.

Comment 14:

P10 L4: “This sentence rise doubts if the authors have been in the area and it prooves that they are not at all familiar with vegetation ecology: Please check Zhang 1988 Vegetation of Xizang, Noelling. The NC catchment has open dwarf scrub of Juniperus pingii v wilsonii, on the southern slope as well; the only relics of trees are found in Nindung Xiang, described by sources cited in this paper - I am confused what has happened”

Author′s response: We agree with the reviewer′s demand to clarify our formulations. We rewrote the sentence to make clear that there are currently no trees in the Nam Co catchment.

Author′s changes in manuscript: The sentence now reads: “There is no evidence of tree species, except for the evergreen shrubs of Juniperus pingii var. wilsonii, which are mainly found on south-facing slopes in the northern Nam Co catchment, and shrubs of Salix spp., which are present in the Niyaqu Valley in the eastern lake catchment (Li, 2018).”

Comment 15:

P10 L6: “this sentence is absolutely enigmatic or meaningless”

Author′s response: We agree, this sentence should be omitted.

Author′s changes in manuscript: We omitted the sentence and also P10 L10 f., as it holds no additional information.

Comment 16:

P10 L23: ”please check if K. tibetica is really recorded in the NC area. It usually is in the NE plateau.”

Author′s response: We double checked the occurrence of K. tibetica in the Nam Co area. Based on personal communications with Prof. Tsechoe Dorji, who has been working in the Nam Co area for the past decade, we are confident that Kobresia tibetica

is also present there. Furthermore, the species is listed in Chen and Yang (2011). For the sake of completeness, we added Kobresia schoenoides to the list, as it is present in the Nam Co area as well.

Author′s changes in manuscript: The new sentence was changed to: “[. . .] or Kobresia tibetica (Yu et al., 2010) and Kobresia schoenoides (Nölling, 2006).”

Comment 17:

P10 L24: ”possibly !!!!”

Author′s response: We did not include the word “possibly” because it does not fit the sentence. We agree that the influence of grazing on pasture degradation should be discussed. This is why we added a more in-depth discussion to highlight the dominating influence of environmental factors on pasture degradation, rather than just grazing (except for overgrazing in the vicinity of settlements and due to fencing of cattle).

Author′s changes in manuscript: Chapter 2.4 now contains several text passages dedicated to the topic of causes for pasture degradation. For detailed changes see comment 18.

Comment 18:

P10 L27 “please check Yun Wangs PhD in Halle. This is the most relevant source in this issue”

Author′s response: We read Wang’s dissertation and also checked the respective publications.

Author′s changes in manuscript: Several changes were made in chapter 2.4 that includes the results of Wang and her co-authors. We also used more local studies related to the Nam Co catchment to verify the statements of Yun Wang et al.: “This effect, however, seems to be limited to the direct vicinity of herder′s settlements and camps (piosphere-centers), and many factors that are usually attributed to degrada-

tion rather proof to be environmentally controlled, especially in drier areas (Wang et al., 2018). Some researchers argue that climate change is the dominant or even sole driver of degradation (Wang et al., 2007), although the effects of rising temperatures and increasing precipitation appear to be an intensifier rather than the cause of degradation (Zhou et al., 2005; Harris, 2010). In turn, both Wang et al (2018) and Cao et al. (2019) point out that a multitude of effects might be in play, with a locally differing magnitude or even reversion, while usually moderate grazing was not to be found to cause degradation. Certainly, there are more factors than just grazing-pressure, and there might be site-specific effects leading to non-equilibrium behavior of the study object, be it pasture or steppe (Wang and Wesche, 2016). Plot-level experiments from the Nam Co area found warming to have significant effects on the shallow rooted Kobresia pygmaea by reducing the number of flowers and delaying its reproductive phenology. These changes were provoked by simulating increasing precipitation by means of snow addition (Dorji et al., 2013) and also by maintaining a moderate level of grazing combined with snow addition (Dorji et al., 2018). This underlines the importance of climate forcing on the terrestrial systems in the Nam Co catchment. Grazing should not be seen as a disturbance but as an integral part of a non-steady state but plagioclimax environment.”

Comment 19:

P11 L3: “it is a well known fact of Chinese experts that the traditional management was sustainable and the trouble started with political interferences ignoring the grassland science of Chinese research stations”

Author′s response: We agree with the referee about this point. We modified the sentence to account for any ambiguities.

Author′s changes in manuscript: We deleted the first part of the sentence which now reads: “The Chinese government has favored policies such as sedentariness and fostered the construction of stationary settlements, which have, in turn, created hotspots

of overgrazing (Miehe et al., 2008)."

Comment 20:

P11 L11: "this is a citation of Miehe et al. 2011 Applied Vegetation Science 14: 547-560"

Author′s response: We thank the reviewer for that comment! We added the citation

Author′s changes in manuscript: We added the citation (Miehe et al., 2011).

Comment 21:

P12 L4: "The correct naming is Juniperus pingii var. wilsonii. The elevational limits are not correct.. Please check with Google Earth. Please pass the whole manuscript to a vegetation ecologist: Please check with Wikipedia o other sources what "ruderal" means"

Author′s response: Thank you very much for your advice! We changed the name from Juniperus pingii to Juniperus pingii var. wilsonii throughout the entire manuscript. Furthermore, we adjusted the elevation limits in figure 4. Approximate biome elevations were taken from satellite imagery (Sentinel 2B) and herewith derived vegetation indices, field excursion and literature review (Wang and Yi, 2011; Ohtsuka et al., 2008).

Author′s changes in manuscript: See author's response above.

Comment 22:

P14 L6: "The whole section could be improved to a valuable introduction if more sources would be involded, but it is the question if such a state of the art is necessary to point out the specific situation of NamCo"

Author′s response: The aim of this section is to provide a more general overview about the interdependencies of geodiversity and biodiversity on the TP by citing most relevant studies on this topic. To provide a valuable introduction, we carefully restructured the

whole section and also pointed out the implications for the Nam Co catchment (see also comment no. 1).

Author′s changes in manuscript: The restructured paragraph now reads: "Topography, geological context, climate and their complex interplay are key determinants for the distribution of organisms. In general, the ecoregion can serve as a proxy for community- and species-level biodiversity, which best describe communities of mammals, birds and plants (Smith et al., 2018). The TP forms a distinctive zoographical region, an "ecological island" (Deng et al., 2019), characterized by fauna that is adapted to high altitudes, drought, low temperatures and low oxygen levels (He et al., 2016). The TP is forming a unique high-altitude biogeographical biota by harboring also many unique lineages of other organisms, with higher endemism of low dispersal species (Yang et al., 2009; Clewing et al., 2016). As mountain building has been directly associated with the development of biodiversity (Hoorn et al., 2013; Antonelli et al., 2018), the biodiversity hotspots are located especially in the south and south-east of the TP. There is also a pattern of increasing biodiversity from west to east, which correlates positively with increasing precipitation. In contrast, the harsh central areas of the TP show much lower richness, but nevertheless harbor various endemics (Päckert et al., 2015). Throughout the geological formation of the TP, the mountainous south-eastern parts have been hypothesized to serve as center of species diversification (Mosbrugger et al., 2018), although the core TP region is also suggested to represent a center of origin (Deng et al., 2011). The TP has been a source area for several mammalian lineages (Out-of-Tibet hypothesis; Deng et al., 2011), including the snow leopard and the arctic fox (Wang et al., 2015), as well as birds, such as redstarts (Voelker et al., 2015), and plants, such as Gentiana (Favre et al., 2015). These mountainous areas may also have acted as refugia, which preserved unique lineages over long periods (LópezâĂŘPujol et al., 2011; Lei et al., 2014). Whether some endemic taxa represent relics of a formerly more diverse clade or have never extensively diversified, remains unclear (Päckert et al., 2015). Besides being a center of origin, the TP may represent a center of accumulation as proposed by the examples of Saxifraga (Ebersbach et al., 2017), warblers

(Johansson et al., 2007) and hynobiid salamander (Zhang et al., 2006). Overall, the regional biota of the TP is comprised mainly of Palearctic and Oriental species, Nearctic species from the Bering land bridge, as well as species from speciation in situ, and postglacial recolonization from adjacent areas. The evolution of biodiversity on the TP has been affected by the combination of geological and climatic changes over the time of the uplift phases (Mosbrugger et al., 2018). Although many studies have associated recent in situ radiations to different uplift phases of the TP, Renner (2016) pointed out that the evidence for recent rapid uplift (9–8 or 3.6–2.6 Ma) remains doubtful and controversial. As proposed by the "mountain-geobiodiversity" hypothesis, the evolution of biodiversity on the TP is a result of an increasing local geodiversity in combination with rapid climatic oscillations and steep ecological gradients (Mosbrugger et al., 2018)."

Comment 23:

P14 L10: "sorry there is far more than just fish !"

Author's response: We are not sure to what the reviewer refers by this comment, but the citations in the text are not only fish related but also include results of research on birds, mammals (Yang et al., 2009) and snails (Clewing et al., 2016).

Author's changes in manuscript: No changes.

Comment 24:

P14 L11: "please check the state of the art more careful !"

Author's response: Associated with the comment no. 25. This part has been removed from the manuscript.

Author's changes in manuscript: See comment no. 25.

Comment 25:

P14 L12: "I doubt if the environmental history of the NC has anything in common with the outer declivities like the Himalaya or the Hengduan Shan."

Author's response: We agree with the reviewer's comment. However, the aim of this section is to give a rather more general overview of the TP. Nevertheless, in order to avoid confusions, this sentence has been removed from the manuscript.

Author's changes in manuscript: We have removed the following sentences, P17: "The TP, including Himalayas and Hengduan Mountains, harbor more than 12000 species of seed plants, 1000 species of terrestrial vertebrates and 800 species of birds (Zhang et al., 2016; Zheng and Zhao, 2017). The proportion of endemism among these plants and vertebrates is relatively high, about 38% and 20%, respectively, but only about 4% among breeding birds (Yang et al., 2009). The recorded species richness of fish exceeds the count of 150, with most common and abundant group being endemic schizothoracine (Zheng and Zhao, 2017). As the structure of soil microbial (including fungal) communities are affected by vegetation, climatic and soil parameters, the unique habitats of the TP potentially harbor many unique microbial lineages that are adapted to high altitude and cold environments (Huang et al., 2014)."

Comment 26:

P14 L13: "This is really misleading: the endemism of NC is another story and the sources about endemism have to be included"

Author's response: Associated with the comment 25.

Author's changes in manuscript: The sentences related to endemism percentages were removed from the manuscript.

Comment 27:

P14 L18 "the meaning of this sentence is that the cited sources are not relevant for the NC

Author's response: Although the sentence is not only associated with the Nam Co catchment, as this entire short section, it is relevant for pointing out biodiversity hotspots on the TP.

Author′s changes in manuscript: No changes.

Comment 28:

P14 L21: “there are certainly no tropical forests on the TP since the late Pliocene !!”

Author′s response: While this is true, the authors meant the southern part of TP, the seasonal rainforests of the low altitudes in the eastern Himalayas, which are replaced by conifers at higher altitudes.

Author′s changes in manuscript: The following section has been removed in order to avoid confusion: “One of the driving factors is the strong altitudinal zonation, which creates habitat diversity and forms various ecosystems. On the TP, ecosystems are ranging from tropical rain forest over coniferous forest, shrubland, alpine meadow and alpine steppe to dry and desert steppe with increasing altitude.”

Comment 29:

P15 L5: “if this chapter remains in place, please include Su et al. 2019, who gives a completely different record !”

Author′s response: We thank the reviewer for pointing out new research! However, the suggested reference does not include estimations about the onset of the uplift that we were pointing out to be ca. 50-55 Ma ago as based on Mosbrugger et al. (2018).

Author′s changes in manuscript: Because the onset of the Plateau uplift is still under debate, we removed “started ca. 55–50 Ma ago”. We furthermore included a short chapter in section 3.1, discussing the controversial arguments about the timing of the Plateau uplift (see comments no. 1 and no. 22).

Comment 30:

P15 L18: “why do you not cite Li et al. 1981 ?”

Author′s response: We thank the reviewer to point out that Li et al 1981 also noted that

the drainage possibly changed during the Late Pleistocene.

Author′s changes in manuscript: We incorporated a paragraph about the shift of the drainage regime in chapter 3.1 (see comment no. 1).

Comment 31:

P17 L12: “Plant families are usually written in recte, only gebera and species in italics”

Author′s response: Thank you very much for your advice, we applied the scheme you proposed to the entire manuscript.

Author′s changes in manuscript: Throughout the manuscript, taxonomical family names are now written in normal letters, genus and species names in italics.

Comment 32:

P18 L16: “The phanerophytes of Juniperus and Salicx of the NC are throughout shrubs , not trees. What is your evidence that NC was ever forested ?”

Author′s response: Thank you for pointing this out. We explicitly state that there are no tree species in the catchment.

Author′s changes in manuscript: In chapter 2.4 we now write: “There is no evidence of tree species, and the only evergreen shrub species present are Juniperus pingii var. wilsonii, which is mainly found on the south-facing slopes of the northern Nam Co catchment, and Salix spp. in the Niyaqu Valley in the eastern lake catchment (Li, 2018).”

Comment 33:

P18 L24: “again: no evidence.”

Author′s response: We created a better link between chapters 2.4 and 3.3, where we discuss this hypothesis now with more distance and more critical. Our revised statements are now given in subjunctive, and we do point out that the hypothesis cannot

be directly corroborated by the data currently accessible to us. However, we do state that we see a strong but not unambiguous hint for anthropogenic influence that might have led to severe changes of the landscape.

Author′s changes in manuscript: The end of chapter 3.3 now reads: “Furthermore, the occurrence of synanthropic taxa has been observed in the nearby Damxung valley since 8.5 cal ka BP (Schlütz et al., 2007). This corroborates the strong anthropogenic influence on the formation and restructuring of vegetation patterns in the area but leaves a time gap of almost 3 ka between the evidence from Damxung valley and Nam Co. Hence, further research is needed to address the question of onset of human activity and degree of landscape modification.”

Comment 34:

P18 L28: “ecosystems”

Author′s response: Thank you for your advice, we corrected this spelling error.

Author′s changes in manuscript: It now reads “ecosystems” instead of “Ecosystems”

âĂČ References

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