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The Cryosphere Discussions

Interactive comment on "Thermal impacts of engineering activities on permafrost in different alpine ecosystems in Qinghai-Tibet Plateau, China" *by* Qingbai Wu et al.

Anonymous Referee #2

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The manuscript" Thermal impacts of engineering activities on permafrost in different alpine ecosystems in Qinghai-Tibet Plateau, China" presents measurements of the ground thermal regime in a range of settings impacted by construction activities. Although the manuscript contains a number of interesting data sets and findings, I do not recommend the manuscript for publication in TC, unless serious revisions are conducted by the authors. In particular, the authors present a number of interpretations for their measurements which are not well enough supported. This could be done by a) a statistical analysis of a sufficient number of samples (= boreholes in this case which is most likely difficult to achieve), or b) a careful, at least semi-quantitative argumentation involving the physics of the system, in particular the heat fluxes related to the thermal

properties of the different parts/layers of the system and possibly the radiative forcing at the surface, or c) a study with a 2-dimensional ground thermal model considering the points raised under b).

Major points:

-The manuscript presents and discusses a lot of measurements in great detail (which is OK). However, some of the conclusions on the underlying processes, although not implausible, are not directly supported by the measurements. Although a number of boreholes exist, their number is too small for a statistical analysis that could secure the interpretations given by the authors. On the other hand, no data on the processes themselves are presented. In the following, I comment on the different results and conclusions as given in the abstract (l. 12 ff): "The results show that alpine meadows on the Qinghai–Tibet Plateau can have a controlling role within engineering construction effects on permafrost beneath embankments. " Why not also alpine steppes? Their controlling role would be different, but they would still have a controlling role?

"The artificial permafrost table (APT) beneath embankments is predominantly controlled by alpine ecosystems, . . ." Is this not a direct consequence of different ALTs before construction?

". . . but the change rate of APT is not closely related with those ecosystems. " Is it possible to draw this conclusion from the few boreholes, considering that the spatial variability could be quite high?

"it is mainly related with cooling effects of railway ballast and heat absorption effects of asphalt pavement." No evidence for this is presented, although it is a plausible conclusion.

"Variation of soil temperature beneath embankments is independent of alpine ecosystems, but variation of mean annual soil temperature with depth is closely related to those ecosystems." It is not clear to me what the authors mean with that and how this

could be explained in terms of changing energy content of the soil.

“The vegetation layer in alpine meadows can have an insulation role within engineering activity effects on permafrost beneath embankments. “ The problem is that the data set does not allow differentiating between the effects of road pavement/railroad grade vs. vegetation removal/no vegetation removal. It is at least possible that the described effects are entirely due to the different heat transfer processes in the roadbed and railroad grade.

“This insulation role is an advantage for alleviating permafrost temperature rise in the short term,” I agree with this finding, the around ten-year time series supports this.

“ but a disadvantage in the long term because of climate warming, suggesting that vegetation layer in alpine meadow should be removed upon initiating engineering construction” No evidence for this conclusion is presented.

-What happens to the insulating vegetation layer when it is buried under the railroad grade? How thick is this vegetation layer, and how would the heat transfer through this layer interact with the heat transfer through the railroad grade/road bed during different times of the year? How would lateral heat transfer play a role? Could the different geometries of the roadbed/the railroad grade play a role? Is it certain that winter snow cover can entirely be neglected in the discussion (the authors state that there is no steady or winter-long snow cover)? Is there snow accumulation at the shoulders of the road/railroad? What causes the significant offset between MAAT and MAGT (Table 2) if it is not snow? Is this related to radiative heating of the surface and thereby caused difference between MAAT and MAGST?

-Please revise the English language!

Minor points:

L. 32: How do you define alpine meadow and alpine steppe?

L. 38: Please explain what is meant with “increasing permafrost table”?

L. 54: How are the conclusions of the study influenced by the fact that the boreholes in alpine meadow are at the centerline of the QTR, but at the shoulder for alpine steppe?

Fig. 1: What is meant by “Country” in the figure legends?

l. 107: I don‘t understand this sentence. What is meant by “cool energy” and why should this be the case?

l. 124: What is meant by “contributed”? Wouldn’t it rather be “caused by”?

l. 126: What is meant exactly by “engineering activity increase of APT”?

l. 175: But this vegetation layer will decay and compress over time, thus changing its thermal properties? Is there any evidence how the “vegetation layer” under the railway looks today and how fast this process of decay/compression has occurred/is occurring?

l. 183: I don’t think that QTH and QTR are really comparable – one is a road, the other one a railroad grade, with completely different thermal properties. It is thus not necessarily clear that the described effect on ground temperatures is due to the vegetation layer.

l. 217: Why is it a disadvantage? I don’t think this follows from this study; at least no evidence for this is presented.

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