Responses to RC3

(Reviewer's comments in black; authors' responses in blue)

Major comment:
Thaw slumps are an important phenomenon of permafrost degradation and have a significant impact on engineering, ecological processes, and the carbon cycle. This paper by Xia et al. achieves mapping thaw slumps on a large scale with high precision via combining deep learning and manually inspecting. The paper is generally well organized, the objectives are clear, and the methods are also well designed, for instance, using an iterative mapping method to find more thaw slumps with limited training data and assigning a probability for each mapped uncertain thaw slump. Therefore, the results are quite robust. To date, thaw slump investigations on the QTP are still urgent, and hence I think this important dataset would potentially serve as fundamental data for understanding the impacts of thaw slumps in the warming world. I, therefore, think this paper is a nice contribution that can be published in ESSD journal after minor revisions**.**

Response: Thank you for your positive comments and detailed suggestion.

Specific comments:

- P2, L34: Permafrost definition is not originally described in French (2018), please see Van Everdingen, R.O. (1998)

Response: We added this reference according to your suggestion.

- P2, L30: This sentence doesn't seem to constitute causality. Please revise the wording and grammar.

Response: We changed the sentences to:

"The potential damage to infrastructure and the carbon emission of thaw slumps motivated us to obtain an inventory of thaw slumps. We used a semi-automatic method to get 875 thaw slumps, filling the knowledge gap of thaw slump locations and providing key benchmarks for analyzing the distribution features and quantifying spatio-temporal changes."

- P2, L35: ... of **about** 1.06×10^6 km^2

Response: Revised.

- P2, L48: Please put the references behind the corresponding content respectively, rather than putting them at the end together.

Response: We separated the reference according to your suggestion. We also cited a paper about the impact of retrogressive thaw slumps (RTSs) on infrastructure. The sentence is listed below.

"RTSs can significantly disrupt the local environment, for instance, causing damage to infrastructure (Hjort, 2022), changing ecosystems (Kokelj and Jorgenson, 2013), and triggering the release of carbon previously stored in the frozen ground (Turetsky et al., 2020)."

- P3, L66: "cryospheric studies" rather than "cryosphere studies."

Response: Revised.

- P3, L75: There are too many "and" in this sentence

Response: Thank you. We deleted one "and". Now the sentence is

"The study area (Figure 1a) has a length of ~550 km along the Qinghai-Tibet Railway and Highway and a total area of ~54,000 km^2 (lying within the coordinates 90.91° E to 95.15° E and 31.74° N to 35.99° N, Figure 1b)."

- P9, L170: Do you mean the low probability is < 100%, and the high probability is = 100%?

Response: Yes, it is what we meant, but it may lead to misunderstandings. Following the suggestion from Reviewer 2, we changed the previously adopted numerical values of probability to 'high', 'medium', and 'low' according to the four criteria listed in the manuscript.

P14, L264: Please change the "ha" to SI unit.

Response: We used "ha" because the sizes of the retrogressive thaw slumps are moderate. If using "meter" everywhere in the paper, the number will be too long to show in a figure, while using "kilometer", the value is too small. Also, "ha" is widely used in representing the area of RTSs in other papers and is an SI-accepted unit.

Tables & Figures

- **Summary of RS data:** Could you please re-organize the description RS datasets in Sec.3? What about adding one more table regarding to their summary info? For example, data coverage, used bands, spatial resolution, and purpose of each dataset.

Response: We added one table to describe the remote sensing data. The table is shown below.

Table 1 List of the data used for mapping RTSs and analyzing their spatial distribution

	Acquisition time	Spatial coverage	Spectral bands	Spatial resolution	Purpose	Source/Reference
PlanetScope Scenes	July, August 2019 July and August during the years 2016 to 2020	QTEC	red, green, blue	3–5 m	Automatically delineating Manual inspection	Planet Team, 2017

LandSat-8	2013–2016	RTS locations and the surrounding areas within 1km	Panchromatic band	15 m	Manual inspection	Google Earth Engine
			red, green, blue	30 m		
LandSat-5	2009–2016		red, green, blue	30 m		
Sentinel-2	2015–2016		red, green, blue	10 m		
UAV images	August 2020; July 2021	16 Selected sites along the Qinghai-Tibet Highway	red, green, blue	~ 15 cm	Manual inspection	Field surveys
ESRI World Imagery	Since 2010	QTEC	/	< 1 m	Manual inspection	Esri Inc., 2018
SRTM DEM	2000	QTEC	/	30 m	Manual inspection and analyzing RTS distribution patterns	Farr et al., 2007
Vegetation type	/	QTEC	/	1 km	Analyzing RTS distribution patterns	Wang et al., 2016
Soil textures	2010	QTEC	/	1 km	Analyzing RTS distribution patterns	Food and Agriculture Organization of the United Nations, 2019

- **Figure 1:** Could you please add the lake info here so that authors could clearly see the missing data? You could use the public land cover maps, such as the ESA CCI or TP lake inventory from TPDC.

Response: We double-checked and found that in the map product of Zou et al. (2017), the white parts represent some lakes or glaciers. We misunderstood them as missing data. We changed the manuscript accordingly.

- **Figure 6**: (f), (g): I would suggest using bar charts instead of pie charts, so that the data may be more intuitive and easier to compare. The pie charts look a little messy.

Response: We changed them to bar charts. The figure is shown below (new Figure 6).

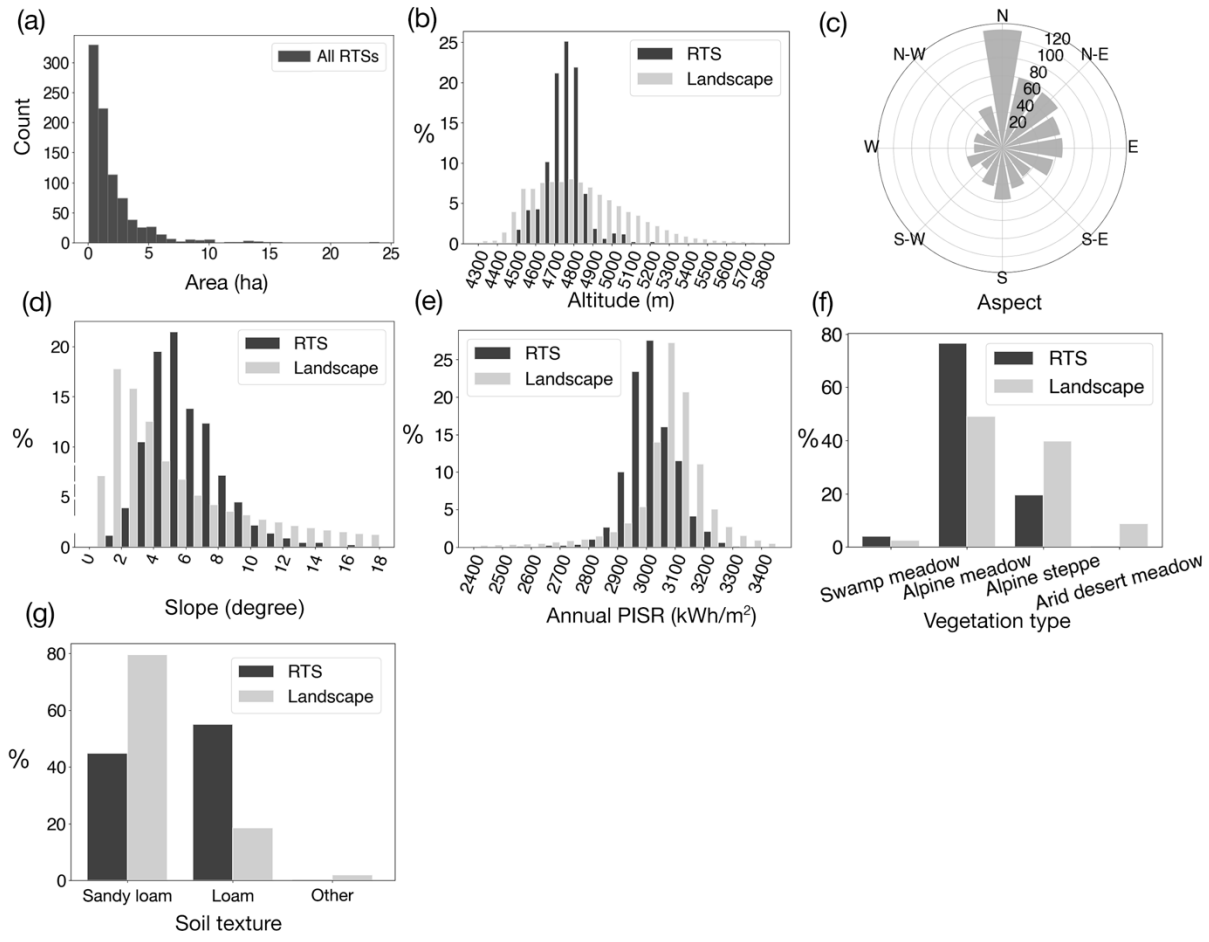

Figure 6. Statistical summaries of the RTSs' geometric features and terrain properties. (a) The histogram shows the area of all the RTSs in the research region. (b) The elevation frequency of the landscape and RTSs. Landscape means the entire study region. (c) The slope aspects of RTSs, with radial axis representing the number of RTSs. (d) The slope frequencies of the landscape and RTSs. (e) The annual PISR frequencies of the landscape and RTSs. (f) The vegetation type distribution of the landscape and RTSs. (g) The soil texture distribution of the landscape and RTSs.