**Supplementary Information**

Figure S1 Map of the 44 sampling sites of permafrost soil and thermokarst lakes across the Qinghai-Tibet Plateau. The distribution of the permafrost was cited from Zou et al., 2017. This map was cited from Ren et al, 2022a.
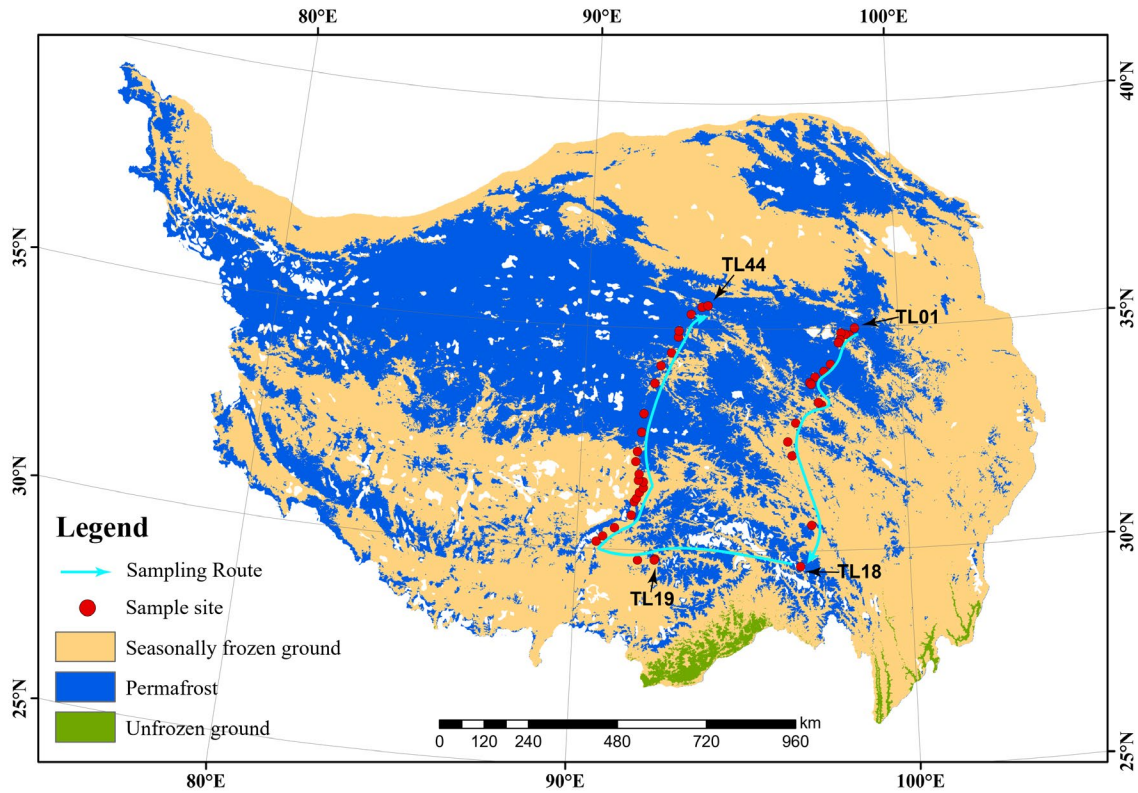
Figure S2 (a) Venn diagram showing the unique and shared OTUs among distinct bacterial communities. (b) The volcano plot showing the shared OTUs that significantly (t-test, $P < 0.05$) enriched in a certain habitat. The volcano plot was constructed using $\log_2$ (fold change) on x-axis and $-\log_{10}$ (p-values of t-test) on y-axis.
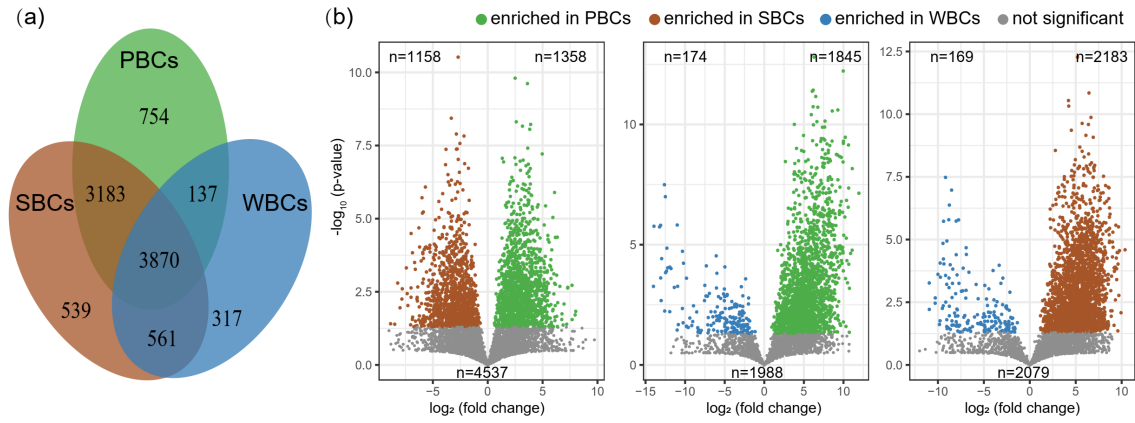
Figure S3 Distance-decay curves showing community similarity against geographic distances between sampling sites. Solid lines denote the ordinary least-squares linear regressions.