Appendix A

Table A1 List of related parameters and equations used in this study

Parameter	Symbol & unit	Depth (cm)	Value / equation	Description
Soil thermal properties				
ClayFrozenC1	b_1; –	0–100	0.0014	Parameters for calculate thermal conductivity of frozen clay-type soil.
ClayFrozenC2	b_2; –	0–100	1.32	
ClayFrozenC3	b_3; –	0–100	0.0036	
ClayFrozenC4	b_4; –	0–100	0.8743	
ClayUnFrozenC1	a_1; –	0–100	0.13	Parameters for calculate thermal conductivity of unfrozen clay-type soil.
ClayUnFrozenC2	a_2; –	0–100	−0.029	
ClayUnFrozenC3	a_3; –	0–100	0.6425	
SandFrozenC1	b_1; –	0–100	0.00158	Parameters for calculate thermal conductivity of frozen sand-type soil.
SandFrozenC2	b_2; –	0–100	1.336	
SandFrozenC3	b_3; –	0–100	0.0375	
SandFrozenC4	b_4; –	0–100	0.9118	
SandUnFrozenC1	a_1; –	0–100	0.1	Parameters for calculate thermal conductivity of unfrozen sand-type soil.
SandUnFrozenC2	a_2; –	0–100	0.058	
SandUnFrozenC3	a_3; –	0–100	0.6245	
Thermal Conductivity (frozen)	k_{hmi}; W/m/° C	0–100	$k_{hmi} = b_1 10^{b_2\rho_s} + b_3\left(\frac{\theta}{\rho_s}\right)10^{b_4\rho_s}$	Thermal conductivity of frozen clay/sand-type soil (Kersten, 1949).
Thermal Conductivity (unfrozen)	k_{hm}; W/m/ ℃	0–100	$k_{hm} = 0.143\left(a_1 log\left(\frac{\theta}{\rho_s}\right) + a_2\right)10^{a_3\rho_s}$	Thermal conductivity of unfrozen clay/sand-type soil (Kersten, 1949).
Heat Capacity	C; J/kg/ ℃	0–100	$C = f_s \Delta z C_s + \theta C_w + \theta_i C_i$	Soil heat capacity.
Solid Volumetric Fraction	f_s; %	0–100	$1-\theta_s$	The volumetric fraction of solid soil material including mineral and organic matter
Heat Capacity (solid)	C_s; J/m^3/ ℃	0–100	2×10^6	The amount of enegy required to raise the temperature of 1 m^3 of the solid soil material 1 ℃.
Heat Capacity (water)	C_w; J/kg/ ℃	0–100	4.18	The amount of enegy required to raise the temperature of 1 kg of water 1 ℃.
Heat Capacity (ice)	C_i; J/kg/ ℃	0–100	2.1	The amount of enegy required to raise the temperature of 1 kg of ice 1 ℃.
Latent Heat of Freezing	L_f; J/kg	0–100	3.34×10^5	The energy required to melt 1 kg of ice.
Latent Heat of Vaporization	L_v; J/kg	0–100	2.45×10^6	The energy required to vapourize 1 kg of liquide water.

Soil hydraulic properties				
Lambda	$\boldsymbol{\lambda}$; –	0–100	Table 2	Pore size distribution index.
Air Entry	$\boldsymbol{\Psi_a}$; cm	0–100	Table 2	Air entry pressure.
Saturation	$\boldsymbol{\theta_s}$; %	0–100	Table 2	Water content at saturation.
Wilting Point	$\boldsymbol{\theta_{wilt}}$; %	0–100	Table 2	Water content at wilting point (15 atm).
Residual Water	$\boldsymbol{\theta_r}$; %	0–100	Table 2	Residual soil water content.
Macro Pore	$\boldsymbol{\theta_m}$; %	0–100	4	Macro pore volume.
Upper Boundary	$\boldsymbol{\Psi_x}$; cm	0–100	1000	Soil water tension at the upper boundary of Brooks & Corey's expression.
Matrix Conductivity	$\boldsymbol{k_{mat}}$; cm/day	0–20	177.6	Soil matric conductivity.
		20–40	220.8	
		40–60	312.0	
		60–80	624.0	
		80–100	103.2	
Total Conductivity	$\boldsymbol{k_{sat}}$; cm/day	0–20	177.6	The total saturated conductivity.
		20–40	220.8	
		40–60	312.0	
		60–80	624.0	
		80–100	103.2	
n Tortuosity	$\boldsymbol{n}$; –	0–100	1	Parameter used in Brooks & Corey function.
Unsaturated Hydraulic Conductivity	$\boldsymbol{k_w}$; cm/day	0–100	$k_w = k_{mat}\left(\frac{\Psi_a}{\Psi}\right)^{2+(n+2)\lambda}$	Unsaturated hydraulic conductivity in Brooks & Corey function.
Salt transport				
Adsorption Parameter	$\boldsymbol{s_{adc}}$; –	0–100	1	Adsorption parameter.
Deposition Concentration	$\boldsymbol{c_{Cldep}}$; mg/L	0–100	1	Salt deposition concentration.