Appendix

Table S1. Minimum temperature and date of soil profile of *H. ammodendron* forests of different ages.

Profile (cm)	20a		30a		50a	
	Time	**Temperature(℃)**	**Time**	**Temperature(℃)**	**Time**	**Temperature(℃)**
0–40cm	12.30	−10.93	12.30	−8.44	1.01	−9.78
40–80cm	1.03	−8.29	1.04	−2.60	1.06	−2.20
80–120cm	1.31	2.15	2.06	3.88	2.17	5.05
120–160cm	2.06	4.40	2.18	4.80	2.25	6.20
160–200cm	2.18	6.21	2.28	5.70	2.28	6.82

Note: The entire freeze-thaw period is from November 2018 to May 2019.

Table S2. Regression analyses of soil moisture, temperature, and salt in different soil layers of a 20-year-old *H. ammodendron* forest.

Period	Depth (cm)	Temp.[1] vs. VWC[2]			VWC vs. EC[3]			Temp. vs. EC		
		Equation	R^2	*P*	Equation	R^2	*P*	Equation	R^2	*P*
Freezing	0–40 cm	y = 6.943 + 0.327x	0.887	<0.001	y = –0.065 + 0.021x	0.998	<0.001	y = 0.081 + 0.07x	0.885	<0.001
	40–80 cm	y = 5.946 + 0.279x	0.883	<0.001	y = –0.071 + 0.021x	0.996	<0.001	y = 0.054 + 0.006x	0.851	<0.001
	80–120 cm	y = 3.324 + 0.047x	0.996	<0.001	y = 0.058 – 0.015x	0.538	<0.001	y = 0.010 – 0.001x	0.555	<0.001
	120–160 cm	y = 3.698 + 0.050x	0.985	<0.001	y = –0.004 + 0.001x	0.175	0.001	y = –0.0005 + 0.00005x	0.219	<0.001
	160–200 cm	y = 4.165 + 0.023x	0.961	<0.001	-	-	-	-	-	-
Thawing	0–40 cm	y = 6.084 + 0.279x	0.605	<0.001	y = –0.068 + 0.021x	0.995	<0.001	y = 0.059 + 0.006x	0.593	<0.001
	40–80 cm	y = 4.863 + 0.142x	0.672	<0.001	y = –0.072 + 0.020x	0.937	<0.001	y = 0.025 + 0.002x	0.468	<0.001
	80–120 cm	y = 3.255 + 0.087x	0.825	<0.001	y = 0.057 – 0.015x	0.293	<0.001	y = 0.007 – 0.001x	0.109	0.014
	120–160 cm	y = 3.885 + 0.019x	0.099	0.019	y = 0.002 – 0.0003x	0.0003	0.896	y = 0.005 – 0.001x	0.571	<0.001
	160–200 cm	y = 4.169 + 0.019x	0.914	<0.001	-	-	-	-	-	-
Initial evaporation	0–40 cm	y = 8.063 + 0.007x	0.135	0.002	y = 0.083 + 001x	0.001	0.857	y = 0.101 – 0.001x	0.826	<0.001
	40–80 cm	y = 6.591 + 0.052x	0.923	<0.001	y = –0.537 + 0.092x	0.017	0.299	y = –0.0003 + 0.008x	0.042	0.098
	80–120 cm	y = 3.375 + 0.051x	0.997	<0.001	y = 0.017 – 0.004x	0.759	<0.001	y = 0.003 – 0.0002x	0.758	<0.001
	120–160 cm	y = 3.781 + 0.052 x	0.991	<0.001	y = 0.006 – 0.001x	0.223	<0.001	y = 0.001 – 0.00008x	0.271	<0.001
	160–200 cm	y = 4.050 + 0.037x	0.995	<0.001	-	-	-	-	-	-

[1] Temp., soil temperature. [2] VWC, volumetric water content. [3] EC, electrical conductivity.

Table S3. Regression analyses of soil moisture, temperature, and salt in different soil layers of a 30-year-old *H. ammodendron* forest.

Period	Depth (cm)	Temp. vs. VWC			VWC vs. EC			Temp. vs. EC		
		Equation	R^2	P	Equation	R^2	P	Equation	R^2	P
Freezing	0–40 cm	y = 5.198 + 0.164x	0.949	<0.001	y = –0.065 + 0.018x	0.974	<0.001	y = 0.031 + 0.03x	0.879	<0.001
	40–80 cm	y = 3.525 + 0.047x	0.858	<0.001	y = –0.141 + 0.060x	0.553	<0.001	y = 0.075 + 0.002x	0.203	<0.001
	80–120 cm	y = 4.528 + 0.026x	0.839	<0.001	-	-	-	-	-	-
	120–160 cm	y = 7.238 + 0.008x	0.113	0.007	y = 0.145 – 0.014x	0.123	0.005	y = 0.050 – 0.001x	0.964	<0.001
	160–200 cm	y = 6.501 – 0.043x	0.673	<0.001	y = –0.80 + 0.015x	0.817	<0.001	y = 0.017 – 0.001x	0.837	<0.001
Thawing	0–40 cm	y = 4.822 + 0.129x	0.666	<0.001	y = –0.094 + 0.025x	0.952	<0.001	y = 0.024 + 0.003x	0.459	<0.001
	40–80 cm	y = 3.783 + 0.101x	0.458	<0.001	y = –0.300 + 0.100x	0.689	<0.001	y = 0.088 + 0.017x	0.842	<0.001
	80–120 cm	y = 3.398 + 0.250x	0.668	<0.001	-	-	-	-	-	-
	120–160 cm	y = 4.595 + 0.426x	0.885	<0.001	y = 0.015 + 0.004x	0.840	<0.001	y = 0.035 + 0.002x	0.650	<0.001
	160–200 cm	y = 3.449 + 0.353x	0.951	<0.001	y = –0.011x + 0.04x	0.734	<0.001	y = 0.002 + 0.001x	0.590	<0.001
Initial evaporation	0–40 cm	y = 5.545 + 0.029x	0.932	0.002	y = 0.101 – 0.009x	0.341	<0.001	y = 0.051 – 0.0004x	0.564	<0.001
	40–80 cm	y = 3.549 + 0.075x	0.989	<0.001	y = 0.027 + 0.018x	0.906	<0.001	y = 0.090 + 0.001x	0.907	<0.001
	80–120 cm	y = 3.559 + 0.142x	0.962	<0.001	-	-	-	-	-	-
	120–160 cm	y = 5.283 + 0.202x	0.933	<0.001	y = 0.027 + 0.002x	0.763	<0.001	y = 0.038 + 0.0004x	0.558	<0.001
	160–200 cm	y = 3.824 + 0.224x	0.932	<0.001	y = 0.008 + 0.0002x	0.007	0.513	y = 0.008 + 0.0001x	0.040	0.105

Table S4. Regression analyses of soil moisture, temperature, and salt in different soil layers of a 50-year-old *H. ammodendron* forest.

Period	Depth (cm)	Temp. vs. VWC			VWC vs. EC			Temp. vs. EC		
		Equation	R^2	*P*	Equation	R^2	*P*	Equation	R^2	*P*
Freezing	0–40 cm	y = 3.725 + 0.189x	0.966	<0.001	y = –0.121 + 0.061x	0.932	<0.001	y = 0.106 + 0.011x	0.844	<0.001
	40–80 cm	y = 3.905 + 0.050x	0.994	<0.001	y = 0.043 – 0.009x	0.257	<0.001	y = 0.009 – 0.0004x	0.252	<0.001
	80–120 cm	y = 4.815 + 0.062x	0.994	<0.001	y = 0.080 – 0.005x	0.261	<0.001	y = 0.057 – 0.0003x	0.231	<0.001
	120–160 cm	y = 2.852 + 0.041x	0.991	<0.001	y = 0.014 – 0.004x	0.128	0.004	y = 0.003 – 0.0002x	0.145	0.002
	160–200 cm	y = 10.248 + 0.152x	0.993	<0.001	-	-	-	-	-	-
Thawing	0–40 cm	y = 3.715 + 0.236x	0.806	<0.001	y = –0.123 + 0.058x	0.943	<0.001	y = 0.095 + 0.014x	0.776	<0.001
	40–80 cm	y = 3.946 + 0.054x	0.885	<0.001	y = –0.087 + 0.024x	0.883	<0.001	y = 0.009 + 0.001x	0.882	<0.001
	80–120 cm	y = 4.804 + 0.061x	0.988	<0.001	y = 40.17 – 0.018x	0.182	0.001	y = 0.063 – 0.001x	0.205	0.001
	120–160 cm	y = 2.780 + 0.051x	0.916	<0.001	y = 0.113 – 0.034x	0.935	<0.001	y = 0.018 – 0.002x	0.831	<0.001
	160–200 cm	y = 10.365 + 0.144x	0.957	<0.001	y = 0.045x – 0.0004x	0.048	0.107	y = 0.041 + 0.00006x	0.046	0.116
Initial evaporation	0–40 cm	y = 4.364 + 0.042x	0.781	<0.001	y = 0.204 – 0.021x	0.696	<0.001	y = 0.116 – 0.001x	0.820	<0.001
	40–80 cm	y = 3.972 + 0.053x	0.994	<0.001	y = 0.040 – 0.006x	0.263	<0.001	y = 0.014 – 0.0004x	0.282	<0.001
	80–120 cm	y = 4.745 + 0.072x	0.998	<0.001	y = 0.045 + 0.003x	0.533	<0.001	y = 0.058 + 0.0002x	0.558	<0.001
	120–160 cm	y = 2.776 + 0.051x	0.984	<0.001	y = 0.087 – 0.026x	0.913	<0.001	y = 0.016 – 0.001x	0.917	<0.001
	160–200 cm	y = 10.247 + 0.163x	0.992	<0.001	y = -0.054 + 0.008x	0.841	<0.001	y = 0.031 + 0.001x	0.856	<0.001

Table S5. Groundwater quality parameters in the study area.

Ion	Ca^{2+}	K^{+}	Na^{+}	SO_4^{2-}	NO^{3-}	Mg^{2+}	HCO^{3-}	Cl^{-}	PH	TDS	COD	TN	TP
Content(mg/L)	112.77	4.88	104.19	530.03	65.30	86.89	345.68	69.05	7.38	1073.00	2.70	238.26	0.14

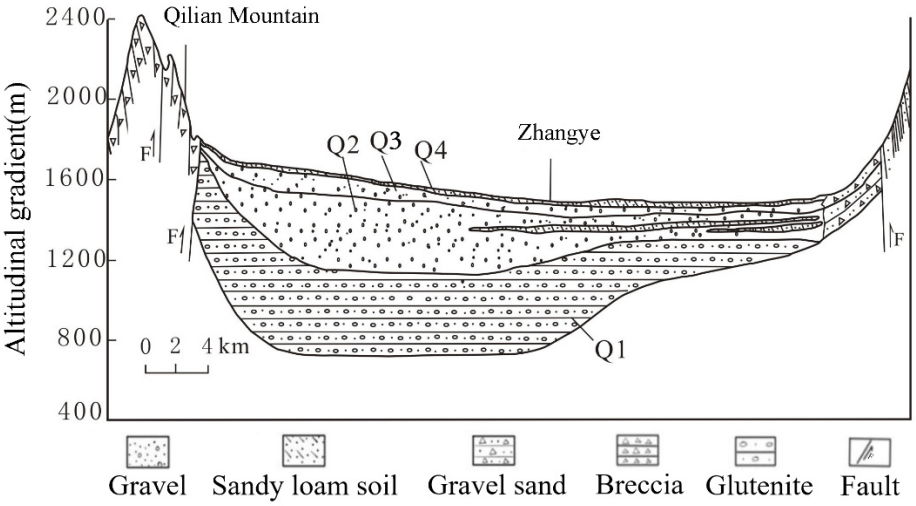


Figure S1. Geological profile of the borehole at the research station. Q1, Q2 and Q3 means Fourth Series Update System, Q4 means Fourth System New System.