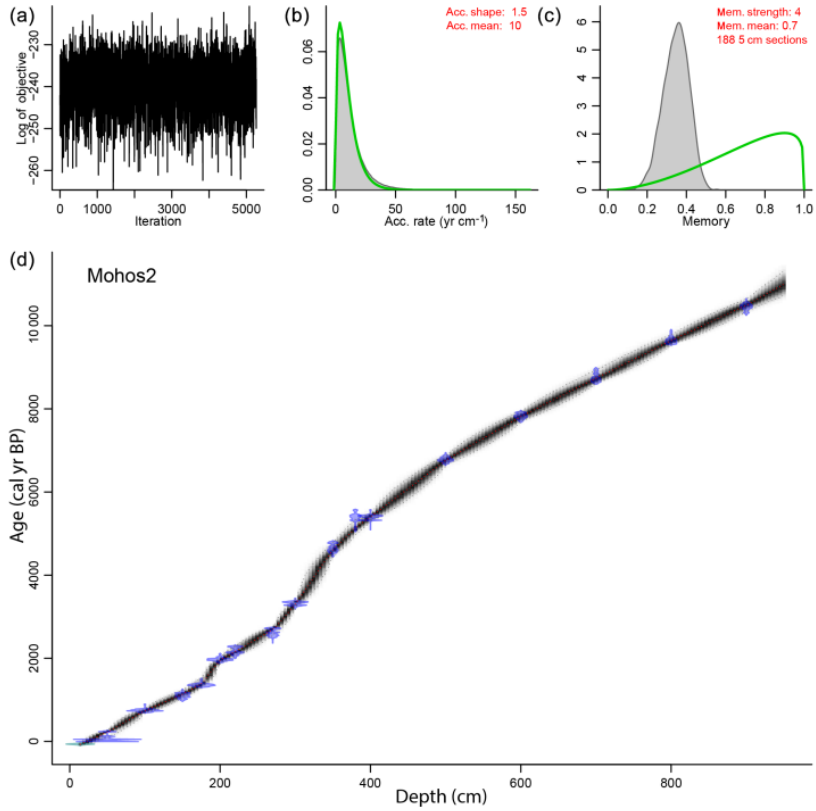
Supplementary Information to “Carbon accumulation rates of Holocene peatlands in central-eastern Europe document the driving role of human impact for the past 4000 years” by Jack Longman et al.

Radiocarbon dating

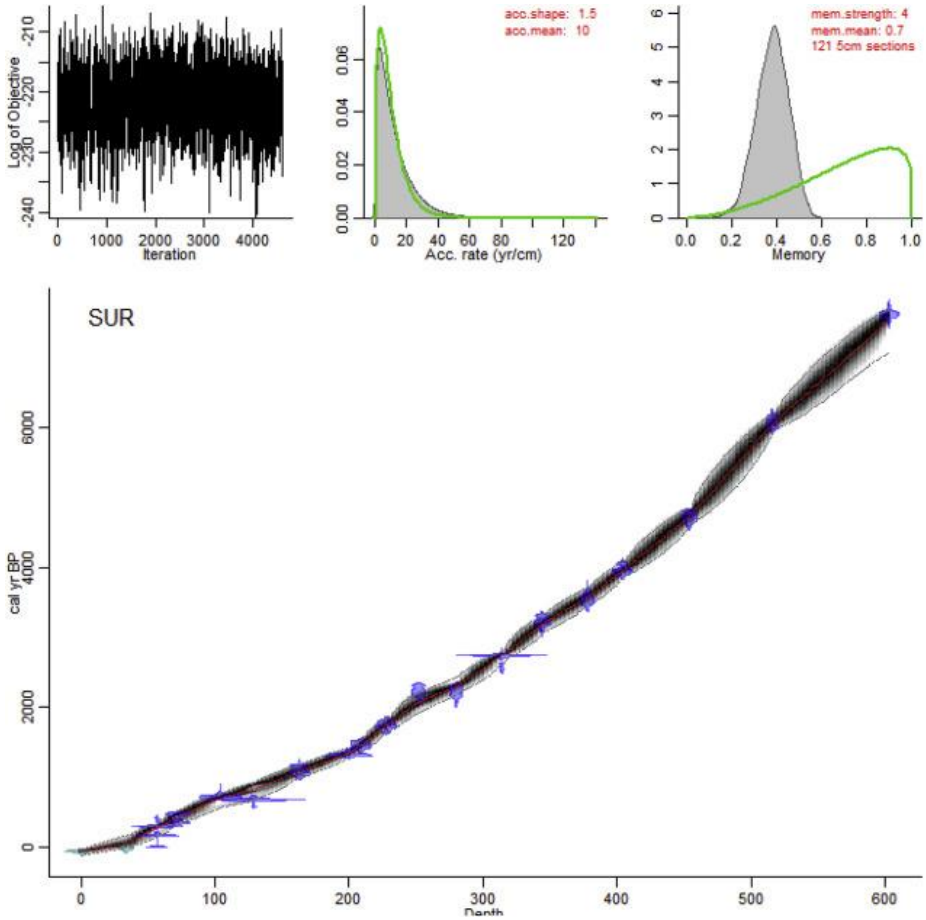
For samples dated at Horia Hulubei National Institute for Physics and Nuclear Engineering, Magurele, Romania (sample code RoAMS), the standard acid-base-acid (ABA) extraction was employed for removing inorganic carbon and humic substances. The protocol follows the steps of the organic materials pretreatment described in Sava et al. (2019). Briefly, the *Sphagnum* stalks were inspected and selected from the bulk sample under the microscope, followed by an acid leaching (3.7% HCl, T = 80 °C, 20 min), ultrapure water rinsing (MilliQ®, Millipore, USA), alkali treatment (0.8% NaOH, T=80 °C, 20 min), ultrapure water rinsing, acid treatment (3.7% HCl, T = 80 °C, 1 hr), followed by ultrapure water washing to neutral pH. At the end of the protocol, the samples were dried. During this protocol the inorganic carbon is dissolved and discarded in acidic solution, the soluble organic carbon (humic acid) is eliminated in the alkali solution, while the alkali insoluble organic carbon (humin) is washed with ultrapure water.

The graphite from organic compounds was produced using an AGEIII system (Ionplus, Switzerland), coupled with and elemental analyzer (VarioMicroCube, Elementar, Germany) for sample combustion (Wacker et al., 2010). Following the graphitization step, the peat graphite was measured on 1 MV AMS system together with a batch of charcoal blanks and modern carbon reference material (NIST SRM 4990C, Oxalic Acid II). The radiocarbon ages were calculated according to Stuiver and Polach (1977) considering blank and fractionation corrections and subsequently calibrated on IntCal13 atmospheric curve (Reimer et al., 2020).

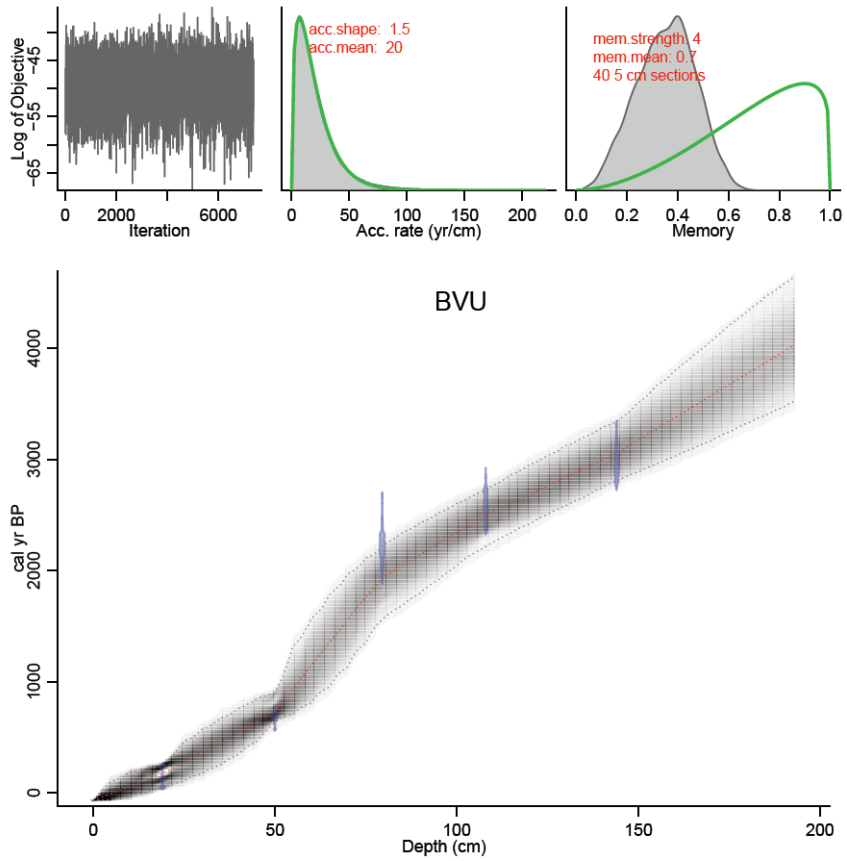
Supplementary Figures



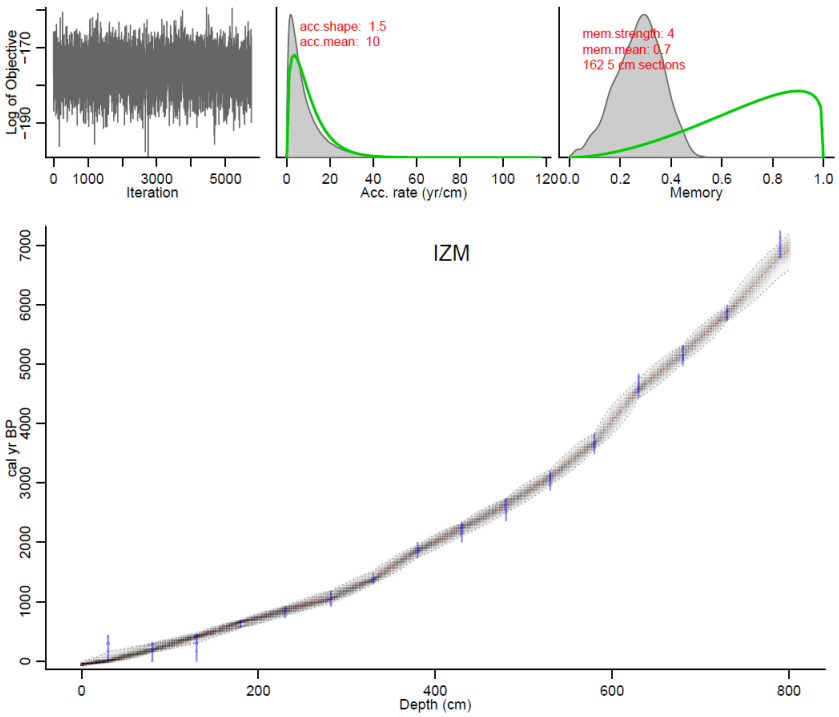
Supplementary Figure 1: Age–depth model of Mohos peat record, as determined via Bacon (Blaauw & Christen, 2011), using IntCal20 (Reimer et al., 2020). (a) Graph indicates Markov chain Monte Carlo iterations. Also in (b) and (c) are prior (green line) and posterior (grey histogram) distributions for the accumulation rate (b) and memory (c). For panel (d), calibrated radiocarbon ages are in blue. The age–depth model is outlined in grey, with darker grey indicating more likely calendar ages. Grey stippled lines show 95 % confidence intervals, and the red curve indicates the single best model used in this work.



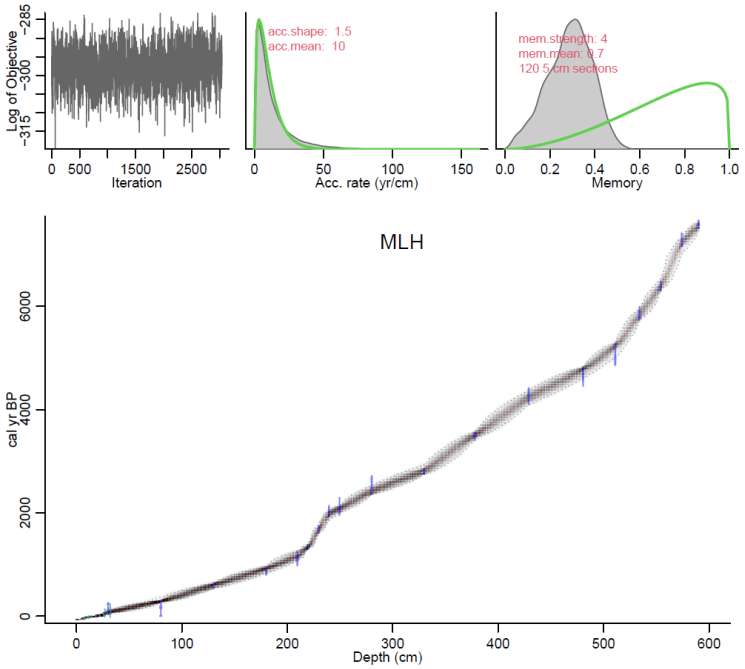
Supplementary Figure 2: Age-depth model of Sureanu peat bog. Panels are the same as in Supplementary Figure 1.



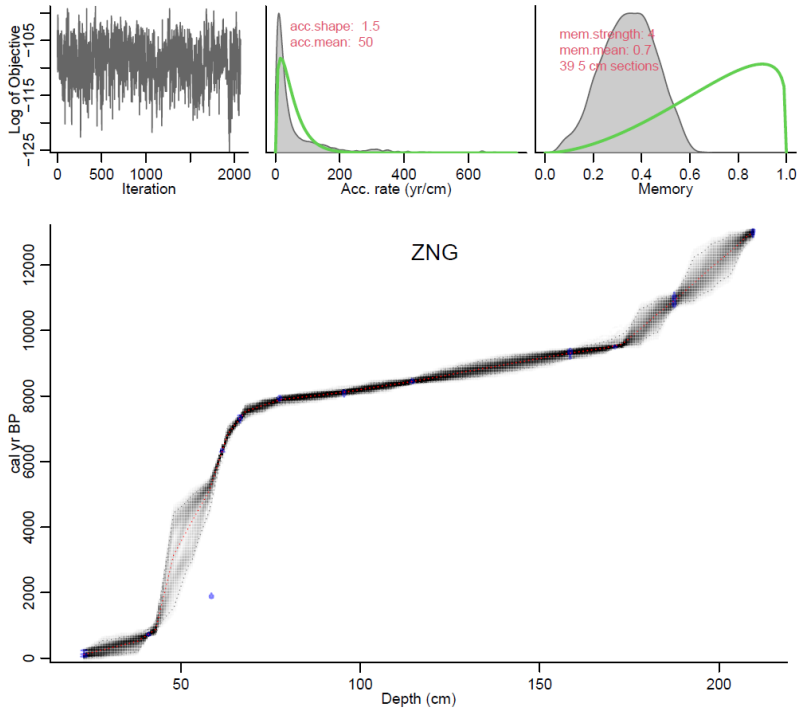
Supplementary Figure 3: Age-depth model of Baia Vultirulor peat bog. Panels are the same as in Supplementary Figure 1.



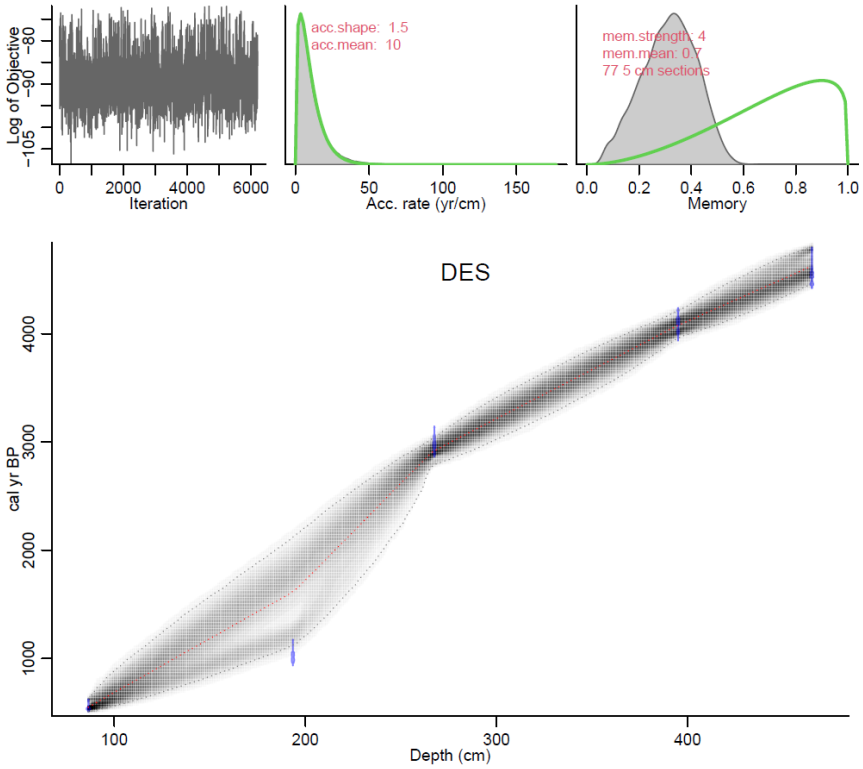
Supplementary Figure 4: Age-depth model of Iezerul Mare peat bog. Panels are the same as in Supplementary Figure 1.



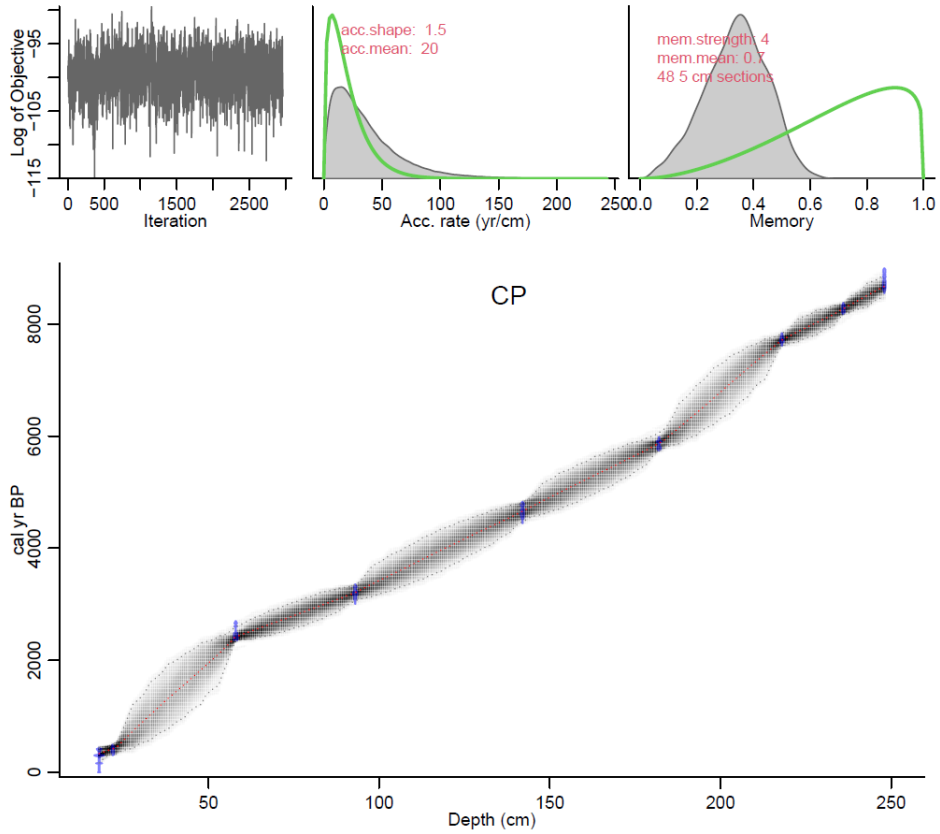
Supplementary Figure 5:Age-depth model of Mluha peat bog. Panels are the same as in Supplementary Figure 1.



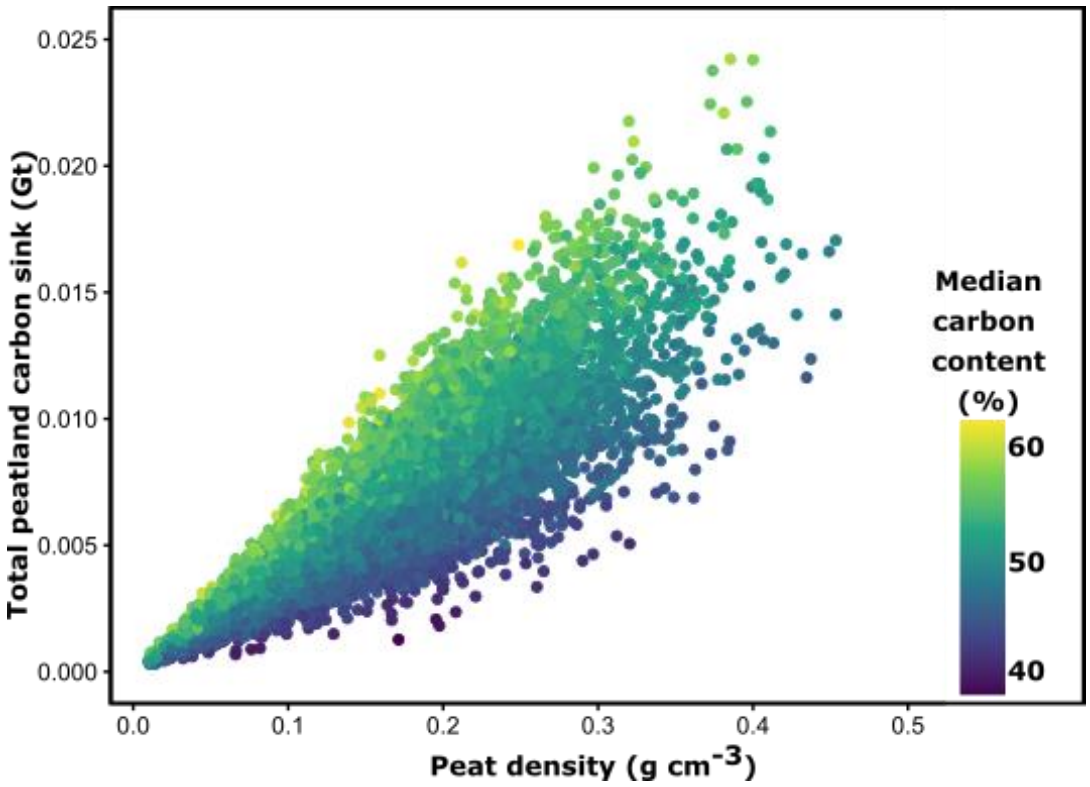
Supplementary Figure 6: Age-depth model of Zanoage Rosie peat bog. Panels are the same as in Supplementary Figure 1.



Supplementary Figure 7: Age-depth model of Despotovac peat bog. Panels are the same as in Supplementary Figure 1.



Supplementary Figure 8: Age-depth model of Crveni Potok peat bog. Panels are the same as in Supplementary Figure 1.



Supplementary Figure 9: Output of Monte Carlo modelling of total carbon sink represented by Romania peat bogs. The total carbon sink is calculated 10,000 times to cover the range of error for each of the variables (see Table 3).

Supplementary Tables

Supplementary Table 1: All radiocarbon dates used in this study.

Sureanu

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
DeA-7256	34	bulk peat	−16 ± 22	
DeA-7257	57	bulk peat	236 ± 23	
DeA-7258	72	bulk peat	368 ± 22	
DeA-7259	104	bulk peat	805 ± 22	
DeA-7260	129	bulk peat	728 ± 21	
DeA-7261	163	bulk peat	1164 ± 25	
DeA-5795	172.5	wood	3176 ± 26	Outlier
DeA-7262	200	bulk peat	1417 ± 26	
DeA-5796	209	bulk peat	1560 ± 27	
DeA-7263	228	bulk peat	1809 ± 22	
UBA-31373	252	bulk peat	2228 ± 44	
UBA-31374	280	bulk peat	2202 ± 44	
DeA-7264	314	bulk peat	2595 ± 24	
UBA-31375	344	bulk peat	3023 ± 30	
UBA-31376	378	bulk peat	3317 ± 50	
DeA-7265	404	bulk peat	3638 ± 29	
UBA-31377	454	bulk peat	4181 ± 32	

DeA-5797	516	bulk peat	5301 ± 36	
UBA-31378	603	bulk peat	6777 ± 54	

Mohos

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
DeA-8343	50	bulk peat	37 ± 18	
DeA-8344	100	bulk peat	838 ± 19	
DeA-10111	150	bulk peat	1174 ± 28	
DeA-10112	175	bulk peat	1471 ± 26	
DeA-8345	200	bulk peat	2022 ± 21	
DeA-10137	225	bulk peat	2155 ± 27	
DeA-10138	280	bulk peat	2530 ± 28	
DeA-8346	300	bulk peat	3112 ± 23	
DeA-10139	350	bulk peat	4110 ± 31	
DeA-10140	380	bulk peat	4641 ± 54	
DeA-8347	400	bulk peat	4638 ± 26	
DeA-10141	500	bulk peat	5949 ± 36	
DeA-10142	600	bulk peat	6989 ± 43	
DeA-8348	700	bulk peat	7909 ± 33	
DeA-10143	800	bulk peat	8687 ± 45	
DeA-8349	900	bulk peat	9273 ± 36	

Crveni Potok

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
Poz-72891	18	Sphagnum stems	260 ± 30	
Poz-72892	22	36 Picea sp. needle pits; 1 Abies sp. needle pits; Sphagnum stems	345 ± 30	
Poz-58430	58	Sphagnum stems; 1 Picea abies Seed; 6 Potentilla fruits; 1 Picea abies Needle	2415 ± 30	
Poz-55928	93	Bark, indet.	3005 ± 35	
Poz-55929	142	Wood (Picea/Larix type)∗	4120 ± 35	
Poz-58431	182	Wood fragments (Larix/Picea or Pinus sp.)	5120 ± 35	
Poz-55930	218	Wood (Picea/Larix type) ∗∗	6890 ± 40	
Poz-55931	236	Wood (Picea/Larix type)∗∗	7460 ± 40	
Poz-55932	248	Wood (Picea/Larix type)	7920 ± 50	

Despotovac

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
DES 2.1	86.5	Bulk sediment	541 ± 11	
DES 2.3	193.5	Bulk sediment	1019 ± 31	
DES 2.5	267.5	Bulk sediment	2989 ± 46	
DES 2.7	395	Bulk sediment	4091 ± 60	
DES 2.9	465	Bulk sediment	4528 ± 60	

Baia Vulturilor

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
RAD-4-2016-1	19	Bulk peat	104.55 ± 1.44	
RAD-4-2016-2	50	Bulk peat	757 ± 50	
RAD-4-2016-3	79.5	Bulk peat	2230 ± 100	
RAD-4-2016-4	108	Bulk peat	2534 ± 100	
RAD-4-2016-5	144	Bulk peat	2820 ± 100	

Iezerul Mare

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
IZM-1.1-30	30	Bulk peat	248 ± 31	
IZM-1.1-80	80	Bulk peat	207 ± 30	
IZM-1.3-130	130	Bulk peat	261 ± 32	
IZM-1.3-180	180	Bulk peat	697 ± 29	
IZM-1.5-230	230	Bulk peat	923 ± 30	
IZM-1.5-282	282	Bulk peat	1093 ± 30	
IZM-1.7-330	330	Bulk peat	1486 ± 30	
IZM-1.7-380	380	Bulk peat	1957 ± 30	
IZM-1.9-430	430	Bulk peat	2191 ± 33	
IZM-1.9-480	480	Bulk peat	2500 ± 33	
IZM-1.11-530	530	Bulk peat	2909 ± 36	
IZM-1.11-580	580	Bulk peat	3403 ± 31	
IZM-1.13-630	630	Bulk peat	4118 ± 38	
IZM-1.13-680	680	Bulk peat	4522 ± 35	
IZM-1.17-730	730	Bulk peat	5109 ± 36	
IZM-1.17-790	790	Bulk peat	6123 ± 54	

Mluha

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
DeA-3695	76	Bulk peat	30 ± 21	
DeA-3696	209	Bulk peat	80 ± 21	
DeA-3697	583	Bulk peat	130 ± 23	
DeA-3698	990	Bulk peat	180 ± 23	
DeA-5789	1180	Bulk peat	209.5 ± 27	
DeA-5790	1436	Bulk peat	219.5 ± 27	
DeA-3699	1799	Bulk peat	230 ± 23	
DeA-5791	2078	Bulk peat	239.5 ± 26	
DeA-5792	2112	Bulk peat	249.5 ± 26	
DeA-3700	2459	Bulk peat	280 ± 25	
DeA-5793	2664	Bulk peat	329.5 ± 27	
DeA-3702	3290	Bulk peat	378 ± 24	
RoAMS: 1399.87	3873	Bulk peat	429 ± 38	
DeA-5794	4130	Bulk peat	480.5 ± 30	
RoAMS: 1400.87	4415	Bulk peat	511 ± 39	

RoAMS: 1401.87	5115	Bulk peat	534 ± 40	
RoAMS: 1402.87	5592	Bulk peat	554 ± 43	
RoAMS: 1403.87	6341	Bulk peat	574 ± 45	
DeA-3703	6730	Bulk peat	590 ± 30	

Zanoaga Rosie

Lab Code	Depth (cm)	Material dated	14 C Age (±1σ)	Remarks
DeA-5798	23	Bulk peat	15 ± 24	
DeA-5799	41	Bulk peat	821 ± 24	
DeA-3680	58.5	Bulk peat	1959 ± 17	Outlier
DeA-8389	61.5	Bulk peat	5525 ± 26	
DeA-8390	66.5	Bulk peat	6411 ± 27	
DeA-5784	77.5	Bulk peat	7121 ± 32	
DeA-5780	95.5	Bulk peat	7280 ± 38	
DeA-3681	114.5	Bulk peat	7654 ± 25	
DeA-3682	158.5	Bulk peat	8308 ± 26	
DeA-5785	171	Bulk peat	8505 ± 34	
DeA-5786	187.5	Bulk peat	9566 ± 38	
DeA-3683	209.5	Bulk peat	11082 ± 33	

Supplementary Table 2: Averages and standard deviations for the variables used in the Monte Carlo modelling.

Variable	Unit	Average	Standard Deviation	Reference
Carbon content	%	50.31	10.87	This study
Bulk density	g cm-3	0.16	0.08	This study
Oligotrophic bog area	km2	13.53	1.37	(Pop, 1960)
Eutrophic bog area	km2	57.31	5.66	(Pop, 1960)
Oligotrophic bog depth	cm	201.62	20.08	(Pop, 1960)
Eutrophic bog depth	cm	90.84	6.44	(Pop, 1960)

Supplementary References

Blaauw, M., & Christen, J. A. (2011). Flexible paleoclimate age-depth models using an autoregressive gamma process. *Bayesian Analysis, 6*(3), 457–474. https://doi.org/10.1214/11-BA618

NIST SRM 4990C. 1983. International Standard Reference Material for Contemporary Carbon-14

Pop, E. (1960). *Mlaştinile de turbă din Republica Populară Română (Peat bogs from Romania)*. Bucharest: Editura Academiei Republicii Populare Române.

Reimer PJ, Bard E, Bayliss A, Beck JW, Blackwell PG, Ramsey CB, Buck CE, Cheng H, Edwards RL, Friedrich M, Grootes PM, Guilderson TP, Haflidason H, Hajdas I, Hatté C, Heaton TJ, Hoffmann DL, Hogg AG, Hughen KA, Kaiser KF, Kromer B, Manning SW, Niu M, Reimer

RW, Richards DA, Scott EM, Southon JR, Staff RA, Turney CSM, van der Plicht J. 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. Radiocarbon 55(4):1869–1887.

Reimer, P. J., Austin, W. E. N., Bard, E., Bayliss, A., Blackwell, P. G., Bronk Ramsey, C., et al. (2020). The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0-55 cal kBP). *Radiocarbon*, *62*(4), 725–757. https://doi.org/10.1017/RDC.2020.41.

Sava T, Simion C, Gâza O, Stanciu I, Păceșilă D, Sava G, Wacker L, Ștefan B, Moșu V, Ghiță D, Vasiliu A. 2018. Status report on the sample preparation laboratory for radiocarbon dating at the new Bucharest RoAMS center. Radiocarbon 61(2): 649–658.

Stuiver M, Polach H. 1977. Discussion: reporting of 14C data. Radiocarbon 19(3):355–363.

Wacker L, Němec M, Bourquin J. 2010a. A revolutionary graphitization system: fully automated, compact and simple. Nuclear Instruments and Methods in Physics Research B 268(7–8):931–934.