

Angolan Highlands peatlands: extent, age and growth dynamics.

Supplementary Material

Table 1. Summary table of satellite sensors and bands used in GEE.

Sensor	Band used	Band Description	Band resolution (m)		
Copernicus Global Land Cover Layers	Discrete classification (Buchhorn et al., 2020)	Land cover classification	100		
Sensor	Bands used in RF classification	Band Wavelength (μm)	Band resolution (m)	Bands used for NDVI with equation	Bands used for NDWI with equation
USGS Landsat 8	Band 2 – Blue	0.452-0.512	30		
	Band 3 – Green	0.533-0.590	30		
	Band 4 – Red	0.636-0.673	30	$(\text{Band } 5 - \text{Band } 4)$	$(\text{Band } 3 - \text{Band } 5)$
	Band 5 – Near Infrared (NIR)	0.851-0.879	30	$(\text{Band } 5 + \text{Band } 4)$ (Rouse et al., 1974)	$(\text{Band } 3 + \text{Band } 5)$ (McFeeters, 1996)
	Band 6 – Shortwave Infrared (SWIR) 1	1.566-1.651	30		
	Band 7 – SWIR 2	2.107-2.294	30		
	ESA Copernicus Sentinel 2	Band 2 – Blue	0.497	10	
Band 3 – Green		0.560	10		
Band 4 – Red		0.665	10		
Band 5 – Red Edge 1		0.704	20		
Band 6 – Red Edge 2		0.740	20	$(\text{Band } 8 - \text{Band } 4)$	$(\text{Band } 3 - \text{Band } 8)$
Band 7 – Red Edge 3		0.783	20	$(\text{Band } 8 + \text{Band } 4)$ (Rouse et al., 1974)	$(\text{Band } 3 + \text{Band } 8)$ (McFeeters, 1996)
Band 8 – NIR		0.835	10		
Band 8A – Red Edge 4		0.865	20		
Band 11 – SWIR 1		1.614	20		
Band 12 – SWIR 2	2.202	20			
Sensor	Band used	Band Description	Band resolution (m)	Function used to calculate slope	Function used to calculate hillshade
NASA SRTM	Band Elevation	Elevation m. asl	30	ee.Terrain.Slope	ee.Terrain.Hillshade

Table 2. Number and size of land cover training polygons

Land Cover Class	Number of training polygons	Size (km ²)
Peatland	12	0.76
Miombo woodland	10	1.14
Valley grassland	8	1.01
Upland grassland	9	1.51
Water	20	0.91
Cleared/cultivated land	16	0.36
Total	75	5.69

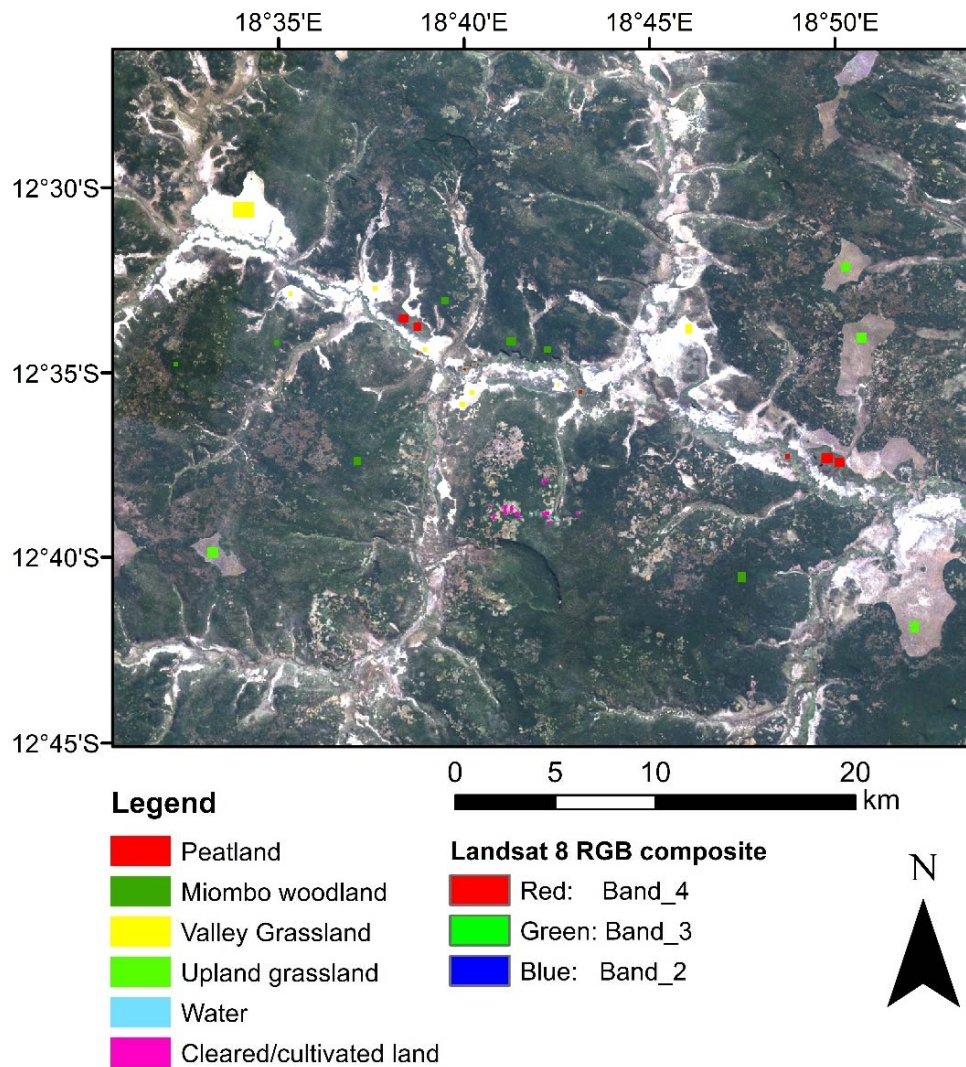


Figure 1. Google Earth Engine training polygons for individual land cover classes.

Table 3. Landsat 8 and Sentinel 2 confusion matrices.

		Reference Data							
L8 Land cover class		Peatland (pixels)	Miombo woodland (pixels)	Valley grassland (pixels)	Upland grassland (pixels)	Water (pixels)	Cleared/ cultivated land (pixels)	Total Pixels (30m)	Commission Error (%)
Classified data	Peatland	265	1	0	1	0	5	272	2,57
	Miombo woodland	0	390	0	0	0	1	391	0,26
	Valley grassland	0	0	362	0	0	1	363	0,28
	Upland grassland	1	0	0	502	0	3	506	0,79
	Water	0	0	0	0	309	0	309	0,00
	Cleared/cultivated land	2	0	2	9	0	99	112	11,61
Total pixels (30m)		268	391	364	512	309	109	1953	
Omission Error (%)		1,12	0,26	0,55	1,95	0,00	9,17		

		Reference data							
S2 Land cover class		Peatland (pixels)	Miombo woodland (pixels)	Valley grassland (pixels)	Upland grassland (pixels)	Water (pixels)	Cleared/ cultivated land (pixels)	Total Pixels (20m)	Commission Error (%)
Classified Data	Peatland	580	1	0	4	0	0	585	0,85
	Miombo woodland	4	873	0	0	0	0	877	0,46
	Valley grassland	0	0	787	0	0	0	787	0,00
	Upland grassland	10	0	0	1123	0	7	1140	1,49
	Water	2	0	0	0	687	0	689	0,29
	Cleared/cultivated land	0	0	4	24	0	234	262	10,69
Total pixels (20m)		596	874	791	1151	687	241	4340	
Omission Error (%)		2,68	0,11	0,51	2,43	0,00	2,90		

Landcover class	Landsat 8				Sentinel 2			
	Pa (%)	Ua (%)	Oa (%)	K	Pa (%)	Ua (%)	Oa (%)	K
Peatland	98.88	97.43			97.32	99.15		
Miombo woodland	99.74	99.74			99.89	99.54		
Valley grassland	99.45	99.72			99.49	100.00		
Upland grassland	98.05	99.21	98.67	0.98	97.57	98.51	98.71	0.98
Water	100.00	100.00			100.00	99.71		
Cleared/cultivated land	90.83	88.39			97.10	89.31		

Table 4. Accuracy assessment of the Landsat 8 and Sentinel 2 RF classifications.

Pa: producer's accuracy, Ua: user's accuracy, Oa: overall accuracy, and K: kappa coefficient.

Overall accuracy was measured by dividing the total number of correctly labelled samples by the total number of the testing samples. The kappa coefficient indicates the degree of agreement between the ground truth data and the predicted values (Mahdianpari et al., 2019). Producer's accuracy represents the probability that a reference sample is correctly identified in the classification map, and user's accuracy indicates the probability that a classified pixel in the land cover classification map accurately represents that category on the ground (Congalton, 1991).

Table 5. Peatland extent for the study including peatland extent of Angola from various sources.

Region and reference	Total area (km ²)	Peatland Area (km ²)
Angolan Highlands (this study)		
Landsat 8 RF classification	61590	5408
Sentinel-2 RF classification		3690
Overlap map from both classifications		1634
Angola		
Andriess (1988)		100
Max for histosols from GDB (2004)	1246700	10261
Best estimate from Page et al. (2011)		2640
1990 estimate from Joosten (2010)		10000
2008 estimate from Joosten (2010)		9910

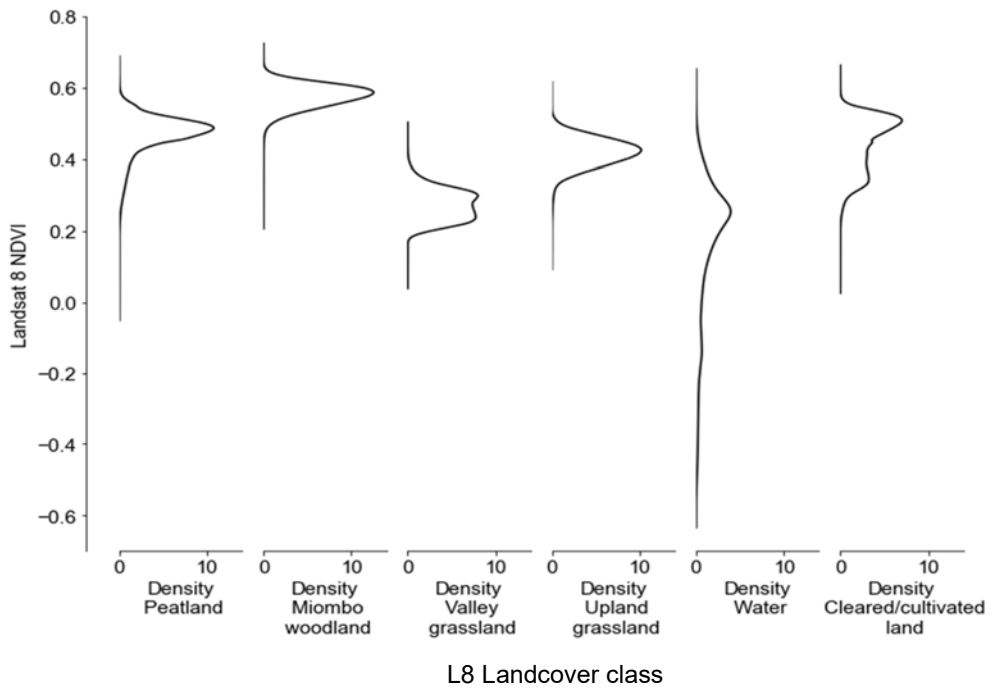


Figure 2. Distribution plots of each L8 landcover class with respect to Landsat 8 NDVI.

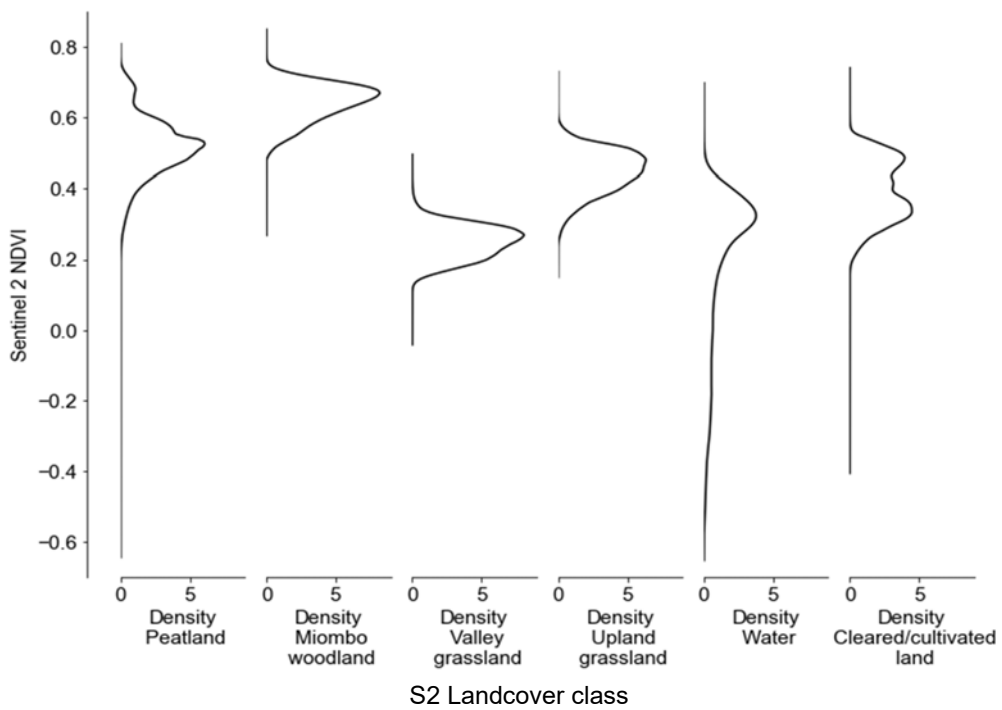


Figure 3. Distribution plots of each S2 landcover class with respect to Sentinel 2 NDVI.

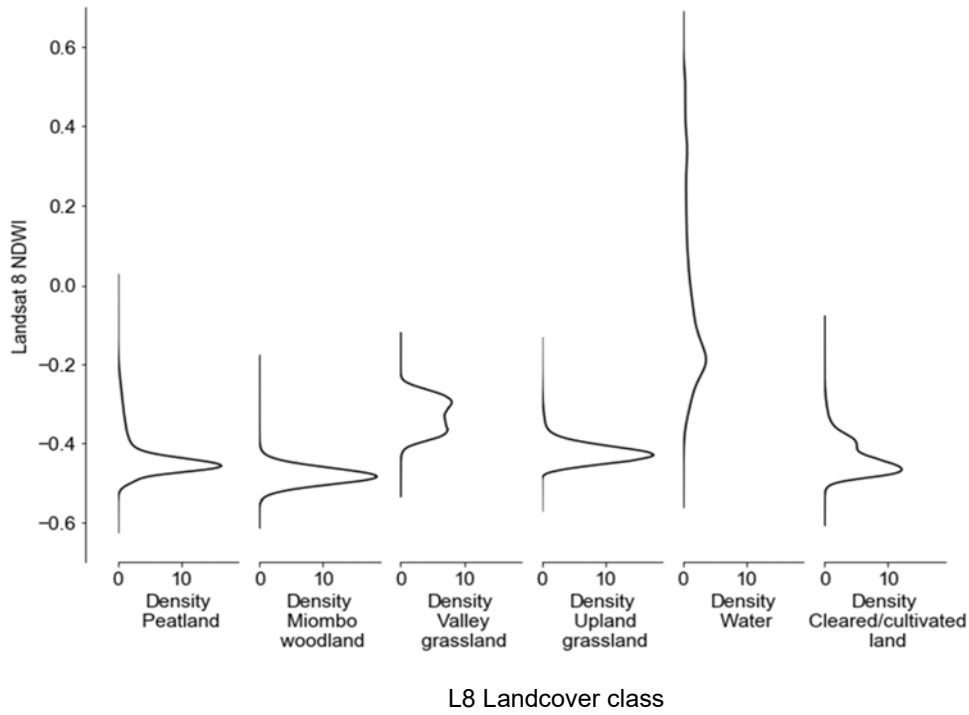


Figure 4. Distribution plots of each L8 landcover class with respect to Landsat 8 NDWI.

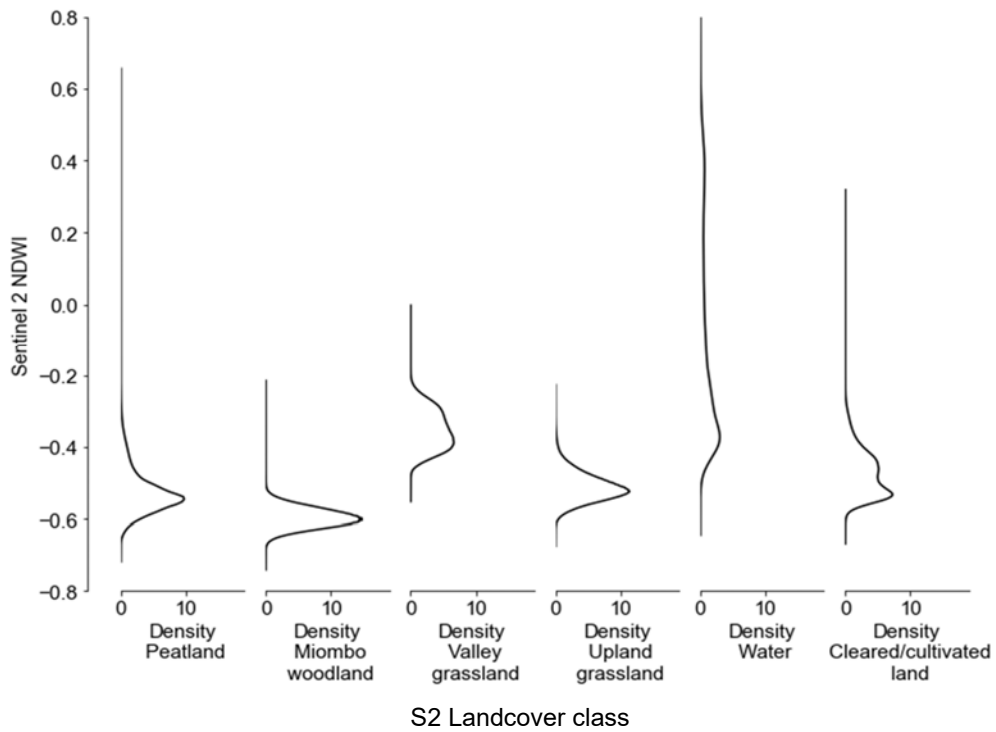


Figure 5. Distribution plots of each land cover class with respect to Sentinel 2 NDWI.

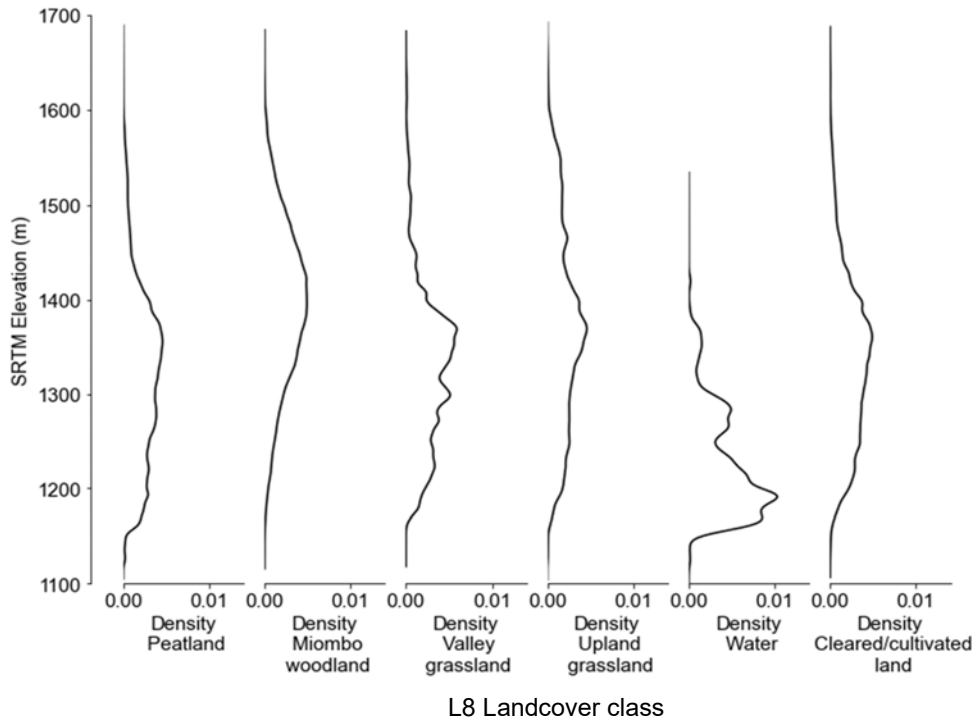


Figure 6. Distribution plots of each land cover class with respect to SRTM Elevation (m).

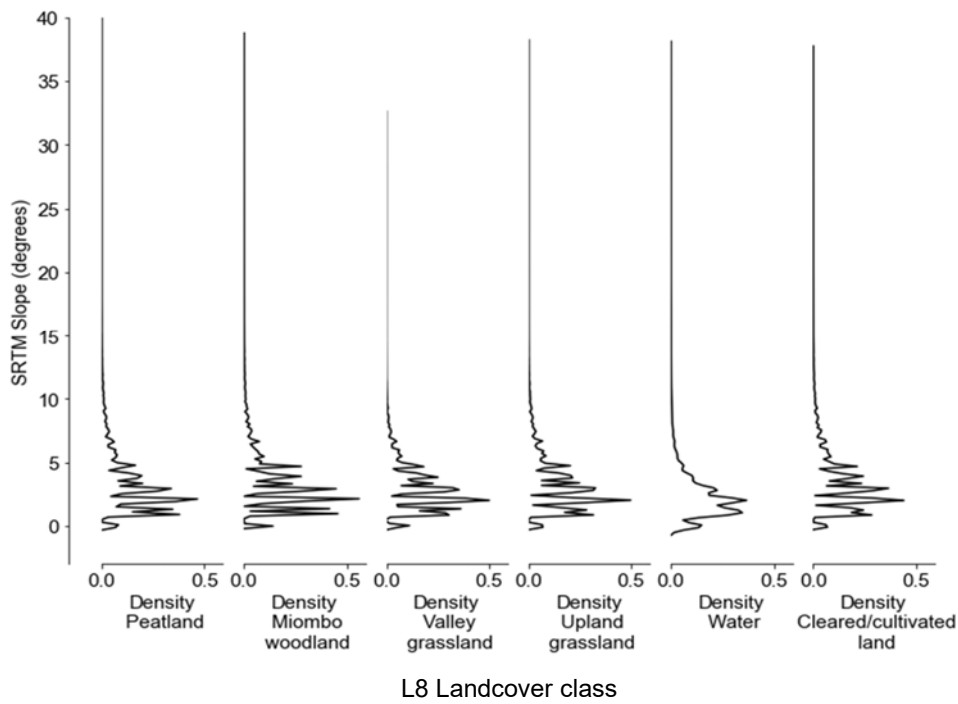


Figure 7. Distribution plots of each land cover class with respect to SRTM Slope

Table 6. AMS ^{14}C dating results for Angolan Highlands peat cores.

Sample	GPS Location	Depth (cm)	$\delta^{13}\text{C}$	pMC	pMC err	Age	Age err
Lungui Bungu River (LB) core 1	12°35'2.85"S, 18°39'57.05"E	0-2	-18.0	103.98	0.81	-	-
		50-52	-15.8	89.38	0.45	900	40
		90-92	-25.0	84.32	0.54	1370	52
LB core2	12°34'51.87"S, 18°40'4.78"E	0-1	-17.9	100.28	0.52	-	-
		30-31	-16.8	85.08	0.63	1300	59
		40-41	-25.3	88.63	0.47	970	42
LB core 3	12°34'57.67"S, 18°40'1.64"E	40-41	-25.3	87.13	0.58	1110	53
		0-1	-17.3	109.00	0.57	--690	-
		30-31	-19.8	86.57	0.54	1160	49
LB core 4	12°35'11.22"S, 18°39'59.80"E	60-61	-24.8	80.81	0.38	1710	38
		0-1	-16.0	107.35	0.71	--570	-
		40-41	-18.6	57.98	0.33	4380	46
Quando Source Lake (CU)	13° 0'16.04"S, 19° 7'36.70"E	70-71	-21.0	46.28	0.41	6190	70
		70-71	-21.0	41.26	0.36	7110	69
		0-1	-16.5	111.06	0.87	-840	-
Cuito Source Lake (CS)	12°41'12.42"S, 18°21'46.40"E	30-31	-16.0	95.15	0.54	400	45
		59-60	-18.9	87.31	0.45	1090	41
		0-1	-16.1	107.09	0.46	-	-
Cuito Source Lake (CS)	12°41'12.42"S, 18°21'46.40"E	0-1	-17.7	108.44	0.72	-	-
		6-7	-18.8	100.75	0.71	-	-
		12-13	-14.8	97.87	0.35	170	29
		18-19	-17.4	97.56	0.43	200	35
		24-25	-16.5	93.71	0.70	520	60
		30-31	-23.0	92.85	0.65	600	56
		30-31	-13.8	93.07	0.79	580	67
		36-37	-17.8	93.04	0.38	580	32
		42-43	-14.6	92.49	0.39	630	34
50-51	-21.3	93.34	0.44	550	38		
Cuanavale Source Lake (CNV)	13° 5'20.32"S, 18°53'40.36"E	0-1	-20.6	110.81	0.49	-	-
		5-6	-19.3	101.19	0.54	-	-
		9-10	-19.3	100.45	0.67	-	-
		14-15	-18.4	97.93	0.38	170	31
		20-21	-17.9	95.75	0.87	350	72
		30-31	-26.5	88.83	0.52	950	47

$\delta^{13}\text{C}$ – this is a measurement that indicates the source of the C in the sample and is used in the production of the final date.

pMC – is an acronym for the “percent modern carbon”, a standard radiocarbon dating term indicating the sample age. Where pMC values exceed 100 it implies that the peat formed post 1950, and no radiocarbon age is reported

err1 – is the error on the measurement of pMC.

Age – this is the age of the sample expressed in “radiocarbon years” before present (1950).

Err2 is the error estimate on the radiocarbon age.

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