Table S1: Path coefficients and model-averaged estimators for each of the *a priori* hypothesized causal relationship among variables (arrows) for the FH horizon.

Direct causal effects

Model	MAT ↓ C_{BioR}	GDD5 ↓ C_{BioR}	MAP ↓ C_{BioR}	WB ↓ C_{BioR}	Sand ↓ C_{BioR}	Silt ↓ C_{BioR}	Clay ↓ C_{BioR}	TSF ↓ C_{BioR}	pH ↓ C_{BioR}	IMD ↓ C_{BioR}	Mn ↓ C_{BioR}
FF1	0.02	-	-	-	-0.10	-	-	0.25 *	0.36 **	0.09	0.35 **
FF1	0.03	-	-	-	-	0.08	-	0.25 *	0.36 **	0.09	0.35 **
FF1	0.02	-	-	-	-	-	0.11	0.24 *	0.36 **	0.08	0.34 **
FF1	-	-0.04	-	-	-0.11	-	-	0.25 *	0.36 **	0.08	0.33 **
FF1	-	-0.03	-	-	-	0.09	-	0.25 *	0.35 **	0.08	0.33 **
FF1	-	-0.05	-	-	-	-	0.12	0.24 *	0.35 **	0.06	0.31 **
FF1	-	-	-0.29 **	-	-0.17	-	-	0.28 *	0.34 **	0.00	0.35 ***
FF1	-	-	-0.30 **	-	-	0.16	-	0.28 **	0.34 **	0.01	0.35 ***
FF1	-	-	-0.26 *	-	-	-	0.12	0.26 *	0.33 **	0.00	0.34 **
FF1	-	-	-	-0.30 **	-0.16	-	-	0.28 **	0.35 **	0.01	0.39 ***
FF1	-	-	-	-0.31 **	-	0.15	-	0.28 **	0.34 **	0.01	0.40 ***
FF1	-	-	-	-0.26 *	-	-	0.10	0.26 *	0.34 **	0.00	0.38 ***
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	**0.25 ***	**0.34 ****	**0.08**	**0.34 ****
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
FF2	-	-	-	-	-	-	-	0.25 *	0.34 **	0.08	0.34 **
Model-averaged estimator	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.34	0.08	0.34

Note: *Model*: model name; *MAT*: mean annual temperature; *GDD5*: growing degree-day above 5°C; *MAP*: mean annual precipitation; *WB*: water balance; *Sand*: sand content of the mineral soil; *Silt*: silt content of the mineral soil; *Clay*: clay content of the mineral soil; *TSF*: time since fire; *pH*: pH of the FH horizon; *IMD*: index of moss dominance; *Mn*: exchangeable manganese; C_{BioR}: carbon bioreactivity of the FH horizon. The model that best fitted the data is highlighted by bold font. (*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Indirect causal effects

Model	TSF ↓ pH	IMD ↓ pH	MAT ↓ IMD	GDD5 ↓ IMD	MAP ↓ IMD	WB ↓ IMD	Sand ↓ IMD	Silt ↓ IMD	Clay ↓ IMD
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-

FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF1	-	-	-	-	-	-	-	-	-
FF2	-0.32 **	0.30 **	-0.22	-	-	-	0.06	-	-
FF2	-0.32 **	0.30 **	-0.22	-	-	-	-	-0.09	-
FF2	-0.32 **	0.30 **	-0.24 *	-	-	-	-	-	0.08
FF2	-0.32 **	0.30 **	-	-0.19	-	-	0.05	-	-
FF2	-0.32 **	0.30 **	-	-0.19	-	-	-	-0.09	-
FF2	-0.32 **	0.30 **	-	-0.22	-	-	-	-	0.09
FF2	-0.32 **	0.30 **	-	-	-0.32 **	-	0.01	-	-
FF2	-0.32 **	0.30 **	-	-	-0.32 *	-	-	-0.04	-
FF2	**-0.32 ** **	**0.30 ** **	**-**	**-**	**-0.33 ** **	**-**	**-**	**-**	**0.06**
FF2	-0.32 **	0.30 **	-	-	-	-0.26 *	0.04	-	-
FF2	-0.32 **	0.30 **	-	-	-	-0.26 *	-	-0.06	-
FF2	-0.32 **	0.30 **	-	-	-	-0.27 *	-	-	0.04
Model-averaged estimator	-0.32	0.30	-0.01	-0.01	-0.25	-0.03	0.00	-0.01	0.05

Note: *Model*: model name; *MAT*: mean annual temperature; *GDD5*: growing degree-day above 5°C; *MAP*: mean annual precipitation; *WB*: water balance; *Sand*: sand content of the mineral soil; *Silt*: silt content of the mineral soil; *Clay*: clay content of the mineral soil; *TSF*: time since fire; *pH*: pH of the FH horizon; *IMD*: index of moss dominance; C_{BioR}: carbon bioreactivity of the FH horizon. The model that best fitted the data is highlighted by bold font. (*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Table S2: Path coefficients and model-averaged estimators for each of the *a priori* hypothesized causal relationships among variables (arrows) for the mineral soil.

Direct causal effects

Model	MAT ↓ C_{BioR}	GDD5 ↓ C_{BioR}	MAP ↓ C_{BioR}	WB ↓ C_{BioR}	Sand ↓ C_{BioR}	Silt ↓ C_{BioR}	Clay ↓ C_{BioR}	TSF ↓ C_{BioR}	pH ↓ C_{BioR}	Mpy ↓ C_{BioR}	Mn ↓ C_{BioR}	Al ↓ C_{BioR}
MIN1	0.24 *	-	-	-	0.23	-	-	-0.11	-0.19	-0.32 *	0.15	-
MIN1	0.21	-	-	-	0.21	-	-	0.06	-0.27 *	-0.3 *	-	-0.42 ***
MIN1	0.24 *	-	-	-	-	-0.22	-	-0.11	-0.18	-0.33 *	0.14	-
MIN1	0.21	-	-	-	-	-0.24 *	-	0.06	-0.26 *	-0.31 **	-	-0.44 ***
MIN1	0.23	-	-	-	-	-	-0.15	-0.11	-0.25	-0.3 *	0.17	-
MIN1	0.18	-	-	-	-	-	-0.02	0.06	-0.31 *	-0.29 *	-	-0.42 **
MIN1	-	0.21	-	-	0.24 *	-	-	-0.08	-0.16	-0.28 *	0.15	-
MIN1	-	0.18	-	-	0.22	-	-	0.08	-0.25 *	-0.26 *	-	-0.42 ***
MIN1	-	0.2	-	-	-	-0.22	-	-0.08	-0.15	-0.28 *	0.14	-
MIN1	-	0.17	-	-	-	-0.24 *	-	0.09	-0.23	-0.27 *	-	-0.44 ***
MIN1	-	0.2	-	-	-	-	-0.17	-0.09	-0.23	-0.26 *	0.17	-
MIN1	-	0.14	-	-	-	-	-0.03	0.08	-0.29 *	-0.26 *	-	-0.42 **
MIN1	-	-	0.24	-	0.25 *	-	-	-0.09	-0.2	-0.33 **	0.13	-

Model	MAT ↓ C_{BioR}	GDD5 ↓ C_{BioR}	MAP ↓ C_{BioR}	WB ↓ C_{BioR}	Sand ↓ C_{BioR}	Silt ↓ C_{BioR}	Clay ↓ C_{BioR}	TSF ↓ C_{BioR}	pH ↓ C_{BioR}	Mpy ↓ C_{BioR}	Mn ↓ C_{BioR}	Al ↓ C_{BioR}
MIN1	-	-	0.22	-	0.23 *	-	-	0.07	-0.28 *	-0.31 **	-	-0.42 ***
MIN1	-	-	0.25 *	-	-	-0.26 *	-	-0.09	-0.18	-0.34 **	0.11	-
MIN1	-	-	0.23 *	-	-	-0.28 *	-	0.07	-0.27 *	-0.33 **	-	-0.44 ***
MIN1	-	-	0.18	-	-	-	-0.12	-0.09	-0.24	-0.3 *	0.14	-
MIN1	-	-	-	-	-	-	0	0.07	-0.31 *	-0.3 *	-	-0.42 **
MIN1	-	-	-	0.16	0.22	-	-	-0.08	-0.17	-0.32 *	0.12	-
MIN1	-	-	-	0.15	0.21	-	-	0.08	-0.27 *	-0.31 *	-	-0.42 ***
MIN1	-	-	-	0.18	-	-0.23	-	-0.08	-0.16	-0.33 *	0.11	-
MIN1	-	-	-	0.17	-	-0.26 *	-	0.08	-0.25 *	-0.32 **	-	-0.44 ***
MIN1	-	-	-	0.12	-	-0.11	-0.11	-0.08	-0.22	-0.3 *	0.14	-
MIN1	-	-	-	0.11	-	0.01	0.01	0.08	-0.3 *	-0.3 *	-	-0.43 **
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
MIN2	-	-	-	-	-	-	-	-0.07	-0.18	-0.28 *	0.12	-
MIN2	-	-	-	-	-	-	-	0.09	-0.27 *	-0.27 *	-	-0.43 ***
Model-averaged estimator	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.05	-0.25	-0.27	0.03	-0.32

Note: *Model*: model name; *MAT*: mean annual temperature; *GDD5*: growing degree-day above 5°C; *MAP*: mean annual precipitation; *WB*: water balance; *Sand*: sand content of the mineral soil; *Silt*: silt content of the mineral soil; *Clay*: clay content of the mineral soil; *TSF*: time since fire; *pH*: pH of the FH horizon; *Mpy*: pyrophosphate extractable metals; *Mn*: exchangeable manganese; *Al*: exchangeable aluminum; C_{BioR}: carbon bioreactivity of the mineral soil. The model that best fitted the data is highlighted by bold font. (*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Indirect causal effects

Model	MAT ↓ Mpy	GDD5 ↓ Mpy	MAP ↓ Mpy	WB ↓ Mpy	pH ↓ Mpy	TSF ↓ pH	Sand ↓ Mn	Silt ↓ Mn	Clay ↓ Mn	Sand ↓ Al	Silt ↓ Al	Clay ↓ Al	pH ↓ Mn	pH ↓ Al

MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MIN2	0.14	-	-	-	-0.37 **	-0.16	-0.07	-	-	-	-	-	0.23	-
MIN2	0.14	-	-	-	-0.37 **	-0.16	-	-	-	-0.02	-	-	-	-0.37 **
MIN2	0.14	-	-	-	-0.37 **	-0.16	-	0.01	-	-	-	-	0.24 *	-
MIN2	0.14	-	-	-	-0.37 **	-0.16	-	-	-	-	-0.05	-	-	-0.35 **
MIN2	0.14	-	-	-	-0.37 **	-0.16	-	-	0.21	-	-	-	0.27 *	-
MIN2	0.14	-	-	-	-0.37 **	-0.16	-	-	-	-	-	0.24 *	-	-0.33 **
MIN2	-	-0.04	-	-	-0.35 **	-0.16	-0.07	-	-	-	-	-	0.23	-
MIN2	-	-0.04	-	-	-0.35 **	-0.16	-	-	-	-0.02	-	-	-	-0.37 **
MIN2	-	-0.04	-	-	-0.35 **	-0.16	-	0.01	-	-	-	-	0.24 *	-
MIN2	-	-0.04	-	-	-0.35 **	-0.16	-	-	-	-	-0.05	-	-	-0.35 **
MIN2	-	-0.04	-	-	-0.35 **	-0.16	-	-	0.21	-	-	-	0.27 *	-
MIN2	-	-0.04	-	-	-0.35 **	-0.16	-	-	-	-	-	0.24 *	-	-0.33 **
MIN2	-	-	0.18	-	-0.39 **	-0.16	-0.07	-	-	-	-	-	0.23	-
MIN2	-	-	0.18	-	-0.39 **	-0.16	-	-	-	-0.02	-	-	-	-0.37 **
MIN2	-	-	0.18	-	-0.39 **	-0.16	-	0.01	-	-	-	-	0.24 *	-
MIN2	-	-	0.18	-	-0.39 **	-0.16	-	-	-	-	-0.05	-	-	-0.35 **
MIN2	-	-	0.18	-	-0.39 **	-0.16	-	-	0.21	-	-	-	0.27 *	-
MIN2	-	-	0.18	-	-0.39 **	-0.16	-	-	-	-	-	0.24 *	-	-0.33 **
MIN2	-	-	-	0.21	-0.38 ***	-0.16	-0.07	-	-	-	-	-	0.23	-
MIN2	-	-	-	0.21	-0.38 ***	-0.16	-	-	-	-0.02	-	-	-	-0.37 **
MIN2	-	-	-	0.21	-0.38 ***	-0.16	-	0.01	-	-	-	-	0.24 *	-
MIN2	-	-	-	0.21	-0.38 ***	-0.16	-	-	-	-	-0.05	-	-	-0.35 **
MIN2	-	-	-	0.21	-0.38 ***	-0.16	-	-	0.21	-	-	-	0.27 *	-
MIN2	-	-	-	0.21	-0.38 ***	-0.16	-	-	-	-	-	0.24 *	-	-0.33 **
Model-averaged estimator	0.01	0.00	0.03	0.11	-0.34	-0.15	0.00	0.00	0.03	0.00	0.00	0.17	0.05	-0.24

Note: *Model*: model name; *MAT*: mean annual temperature; *GDD5*: growing degree-day above 5°C; *MAP*: mean annual precipitation; *WB*: water balance; *Sand*: sand content of the mineral soil; *Silt*: silt content of the mineral soil; *Clay*: clay content of the mineral soil; *TSF*: time since fire; *pH*: pH of the FH horizon; *Mpy*: pyrophosphate extractable metals; *Mn*: exchangeable manganese; *Al*: exchangeable aluminum; C_{BioR}: carbon bioreactivity of the mineral soil. The model that best fitted the data is highlighted by bold font. (*) $p \leq 0.05$; (**) $p \leq 0.01$; (***) $p \leq 0.001$.

Figure S1: Cumulative specific respiration (Rs) as a function of the sampling Julian day. Boxplots represent the distribution of Rs values for each of the soil layers for each sampling day. Lines are drawn for each of the samples. *FH* (green): FH horizon; *MIN015* (blue): mineral soil, top 15 cm; *MIN1535* (salmon): mineral soil, from 15 to 35 cm.