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2 **Table S1** Pearson's correlations coefficients (r) between soil, litter, leaf, and climatic parameters. Correlation analysis was conducted with all five

3 replicates of each of the twelve ecosystems (n = 60)

Variable	Soil				Litter				Leaf							
	$\delta^{15}\text{N}$	N content	$\delta^{13}\text{C}$	C content	C/N ratio	$\delta^{15}\text{N}$	N content	$\delta^{13}\text{C}$	C content	C/N ratio	$\delta^{15}\text{N}$	N content	$\delta^{13}\text{C}$	C content	C/N ratio	
Soil	$\delta^{15}\text{N}$	-0.70****	0.52****	-0.76****	-0.54****	0.82****	-0.13	0.44****	-0.72****	-0.06	0.75****	0.21	0.47****	-0.38**	-0.27*	
	N content		-0.63****	0.96****	0.38**	-0.44****	0.49****	-0.56****	0.72****	-0.26*	-0.38**	0.21	-0.61****	0.34**	-0.15	
	$\delta^{13}\text{C}$			-0.61****	0.01	0.18	-0.60****	0.79****	-0.43****	0.51****	0.15	-0.31*	0.76****	-0.49****	0.28*	
	C content				0.56****	-0.53****	0.38**	-0.54****	0.76****	-0.17	-0.45****	0.07	-0.59****	0.42****	-0.04	
C/N ratio					-0.59****	-0.19	-0.15	0.51****	0.303*	-0.54****	-0.40**	-0.14	0.39**	0.40**		
Litter	$\delta^{15}\text{N}$					0.26*	0.13	-0.68****	-0.48****	0.92****	0.53****	0.20	-0.25	-0.57****		
	N content						-0.66****	0.26*	-0.87****	0.26*	0.26*	0.73****	-0.61****	0.21	-0.64****	
	$\delta^{13}\text{C}$							-0.42****	0.54****	0.14	-0.36**	0.88****	-0.54****	0.22		
	C content								0.11	-0.57****	-0.05	-0.49****	0.39**	0.08		
C/N ratio									0.11	-0.42****	-0.69****	0.47****	-0.12	0.63****		
Leaf	$\delta^{15}\text{N}$									0.53****	0.17	-0.17	-0.61****			
	N content									-0.44****	-0.13	-0.92****				
	$\delta^{13}\text{C}$										-0.44****	0.30*				
	C content											0.19				
C/N ratio																
Soil	pH	0.51****	-0.76****	0.65****	-0.78****	-0.28*	0.26*	-0.51****	0.44****	-0.55****	0.34**	0.20	-0.24	0.45****	-0.40**	0.26*
	clay content	0.14	0.33**	-0.23	0.27*	-0.10	0.32*	0.37**	-0.12	0.02	-0.34**	0.31*	0.44****	-0.16	-0.06	-0.46****
	silt content	0.01	0.27*	-0.04	0.30*	0.20	0.08	0.22	0.02	0.14	-0.23	0.09	0.15	-0.01	0.05	-0.24
	sand content	-0.12	-0.43****	0.22	-0.39**	-0.04	-0.31*	-0.43****	0.09	-0.10	0.41**	-0.31*	-0.45****	0.14	0.02	0.52****
MAP		-0.60****	0.81****	-0.72****	0.76****	0.19	-0.32*	0.58****	-0.65****	0.50****	-0.44****	-0.27*	0.33**	-0.60****	0.34**	-0.26*
	MAT	0.73****	-0.54****	0.66****	-0.60****	-0.33**	0.67****	-0.16	0.55****	-0.62****	0.05	0.61****	0.25	0.55****	-0.48****	-0.33*

4 Levels of significance: * P < 0.05, ** P < 0.01, *** P < 0.001

Table S2 Correlation coefficients (r) and P values of selected variables included in the principal component analysis used to identify the main factors driving soil $\delta^{15}\text{N}$. Only variables showing $r > 0.5$ were considered

Principal component	Variable	r	P value
PC 1	Soil C content	0.93	<0.001
	Soil N content	0.93	<0.001
	Soil C/N ratio	0.61	<0.001
	Soil pH	-0.87	<0.001
	Soil $\delta^{13}\text{C}$	-0.76	<0.001
	MAP	0.87	<0.001
	MAT	-0.63	<0.001
PC 2	Soil clay content	-0.84	<0.001
	Soil sand content	0.82	<0.001
	MAT	-0.65	<0.001

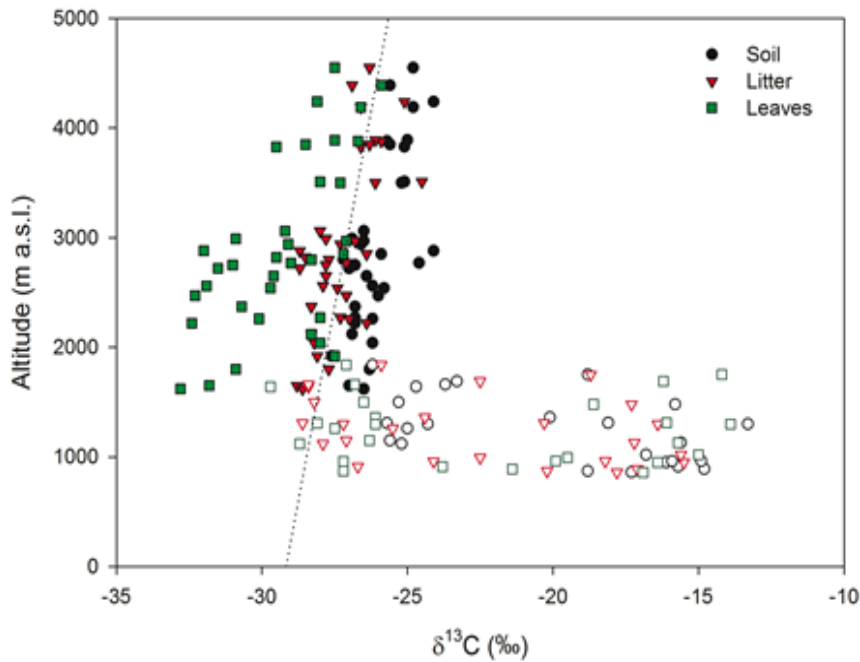


Fig. S1 Variation in $\delta^{13}\text{C}$ values along the Kilimanjaro land-use and elevational gradient for leaves, litter, and soil. Solid symbols denote semi-natural ecosystems, while open symbols correspond to managed ecosystems. The dotted line represents the theoretical global relationship between altitude and $\delta^{13}\text{C}$ of plant leaves (C_3 vegetation only) developed by Körner et al. (1988) and is shown here for reference. The ecosystem acronyms used are as per Table 1. Mai, Cof, and Hom are managed cropping sites, Gra and Sav are extensively managed grasslands and savannas, while the rest represent semi-natural ecosystems. *Reference:* Körner, C., Farquhar, G.D., Roksandic, Z., 1988. A global survey of carbon isotope discrimination in plants from high altitude. *Oecologia* 74, 623–632. <https://doi.org/10.1007/BF00380063>.

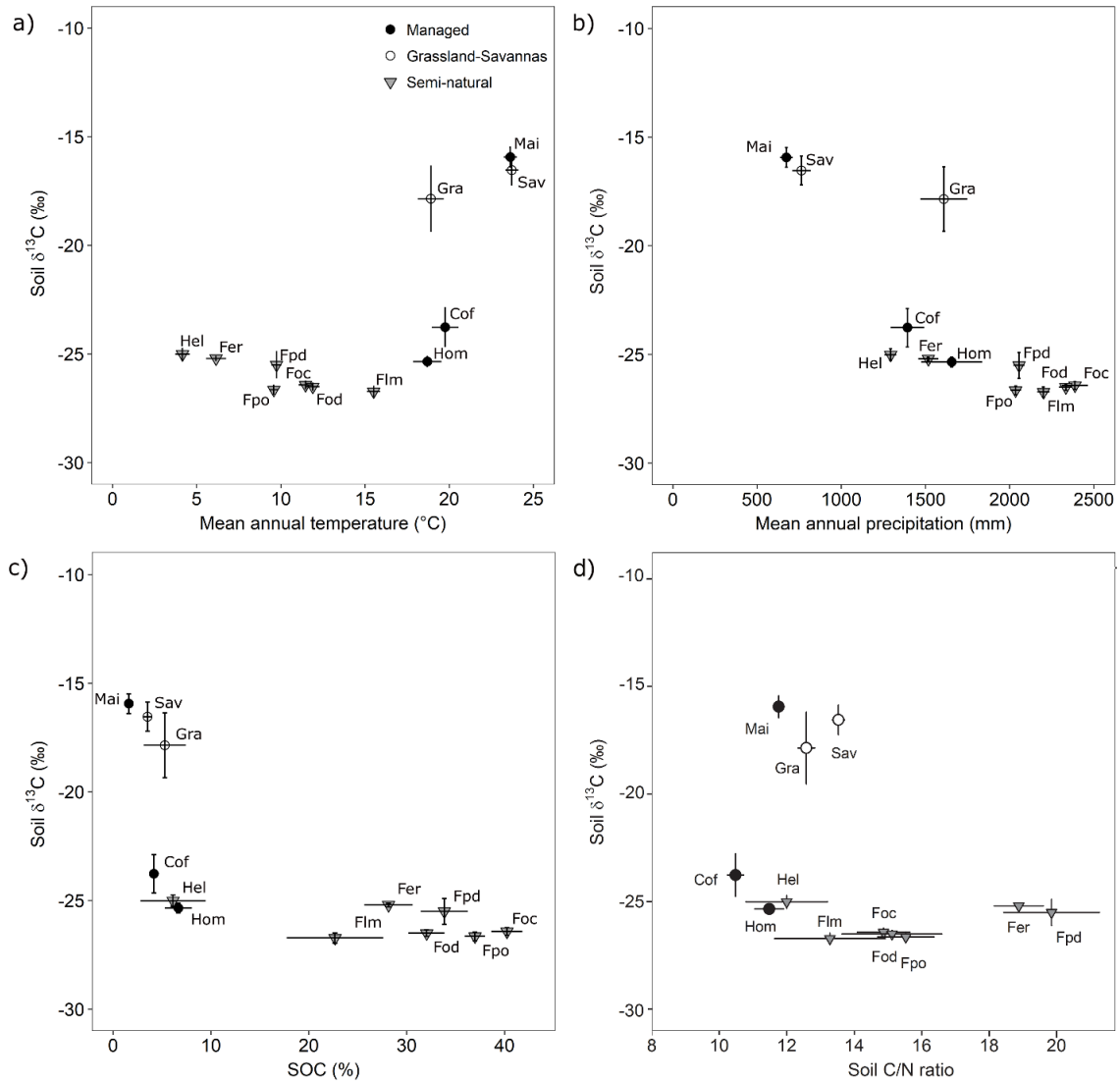


Fig. S2 Relationship between soil $\delta^{13}\text{C}$ values and mean annual temperature (a), mean annual precipitation (b), soil organic carbon (c), and soil C/N ratios (d) for all ecosystems. Each data point represents the average of five sites, and bars denote standard error of the means. Symbols are as per all previous figures. The ecosystem acronyms used are as per Table 1.

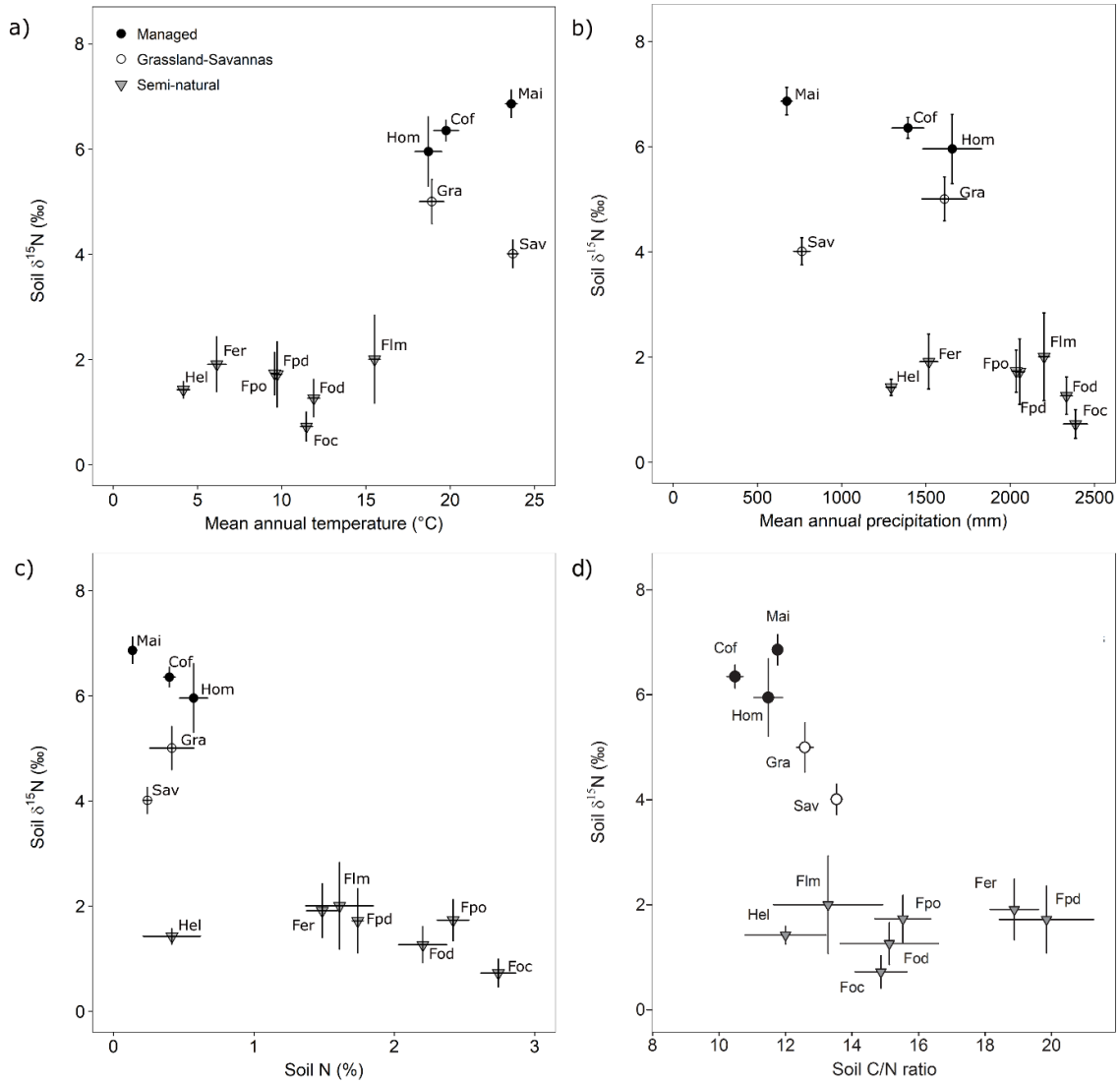


Fig. S3 Relationship between soil $\delta^{15}\text{N}$ values and mean annual temperature (a), mean annual precipitation (b), soil nitrogen (c), and soil C/N ratios (d) for all ecosystems. Each data point represents the average of five sites, and bars denote standard error of the means. Symbols are as per all previous figures. The ecosystem acronyms used are as per Table 1.