Supplementary material

I Raw data of soil property variables and their correlation

TableS1

WGS84 coordinates of the soil sampling locations Pan de Azúcar, Santa Gracia, La Campana.

Research Site	Plot number	Latitude	Longitude
Pan de Azúcar	PdA1	-26.08611	-70.61611
Pan de Azúcar	PdA2	-25.98861	-70.81500
Pan de Azúcar	PdA3	-26.05333	-70.83416
Pan de Azúcar	PdA4	-25.97277	-70.84611
Pan de Azúcar	PdA5	-26.09555	-70.86166
Pan de Azúcar	PdA6	-26.10777	-70.86916
Pan de Azúcar	PdA7	-25.97423	-70.61663
Pan de Azúcar	PdA8	-25.98505	-70.44626
Pan de Azúcar	PdA9	-25.98366	-70.61336
Pan de Azúcar	PdA11	-25.98053	-70.61653
Pan de Azúcar	PdA12	-25.97907	-70.61585
Pan de Azúcar	PdA13	-25.97122	-70.61438
Pan de Azúcar	PdA14	-25.97183	-70.61430
Pan de Azúcar	PdA17	-25.98270	-70.61353
Pan de Azúcar	PdA18	-25.98251	-70.61229
Santa Gracia	SG1	-29.88277	-71.16500
Santa Gracia	SG2	-29.75825	-71.16712
Santa Gracia	SG3	-29.75653	-71.16605
Santa Gracia	SG4	-29.75736	-71.16531
Santa Gracia	SG5	-23.76303	-71.16536
Santa Gracia	SG6	-29.76216	-71.16406
Santa Gracia	SG8	-29.76081	-71.16535
Santa Gracia	SG9	-29.76086	-71.16605
Santa Gracia	SG10	-29.75783	-71.16521
Santa Gracia	SG11	-29.75648	-71.16661
Santa Gracia	SG12	-29.75631	-71.16545
Santa Gracia	SG13	-29.76319	-71.16510
La Campana	LC2	-32.93113	-71.09121
La Campana	LC3	-32.93068	-71.09068
La Campana	LC5	-32.93133	-71.09030
La Campana	LC7	-32.95216	-71.06231
La Campana	LC8	-32.95170	-71.06205
La Campana	LC10	-32.93924	-71.08601
La Campana	LC11	-32.93987	-71.08579
La Campana	LC14	-32.93045	-71.09193
La Campana	LC19	-32.93954	-71.08597

Table S2

Raw data of the physical (clay, silt, sand) and chemical (C, N, P) soil properties. The mean and standard deviation (SD) of the total amount (in both mound and control samples) of the measured soil properties clay, silt, sand, C, N, P as well as the mean and SD of the amount of soil properties of mound and unaffected control samples separately and the percentual input of all properties in all research sites are listed.

Soil properties	Site	Mean and SD of total amount (mound and control)	Mean and SD of mound samples	Mean and SD of control samples	% Input (mound - control)
Clay [%]	Pan de Azúcar	0.10 ± 0.09	0.10 ± 0.09	0.10 ± 0.09	0
	Santa Gracia	0.20 ± 0.11	0.20 ± 0.09	0.19 ± 0.13	5
	La Campana	0.21 ± 0.10	0.18 ± 0.11	0.23 ± 0.09	-28
Silt [%]	Pan de Azúcar	0.38 ± 0.13	0.38 ± 0.12	0.39 ± 0.14	-3
	Santa Gracia	0.14 ± 0.08	0.13 ± 0.08	0.15 ± 0.09	-15
	La Campana	0.25 ± 0.17	0.25 ± 0.18	0.26 ± 0.16	-4
Sand [%]	Pan de Azúcar	0.51 ± 0.12	0.52 ± 0.11	0.51 ± 0.14	2
	Santa Gracia	0.66 ± 0.11	0.67 ± 0.10	0.66 ± 0.12	1
	La Campana	0.54 ± 0.21	0.57 ± 0.23	0.52 ± 0.19	26
C [%]	Pan de Azúcar	2.98 ± 2.66	3.32 ± 2.78	2.64 ± 2.51	20
	Santa Gracia	1.49 ± 0.99	1.74 ± 1.17	1.25 ± 0.71	28
	La Campana	6.65 ± 6.70	8.95 ± 8.74	4.34 ± 2.07	52
N [%]	Pan de Azúcar	0.31 ± 0.33	0.36 ± 0.39	0.27 ± 0.24	25
	Santa Gracia	0.19 ± 0.11	0.20 ± 0.11	0.18 ± 0.11	10
	La Campana	0.57 ± 0.44	0.73 ± 0.55	0.41 ± 0.21	44
P [ppm]	Pan de Azúcar	0.73 ± 0.40	0.78 ± 0.43	0.69 ± 0.37	12
	Santa Gracia	0.74 ± 0.30	0.80 ± 0.31	0.69 ± 0.27	14
	La Campana	0.59 ± 0.26	0.67 ± 0.19	0.53 ± 0.31	21

Table S3

Correlation coefficients and p-values for all dependent variables. Pearson correlation test was applied. Depicted are the correlation coefficients (cor) and the belonging p-values (p) for the differences between mound and unaffected control of all possible combinations of the physical (clay, silt, sand) and chemical (C, N, P) soil properties. Significance level: p<0.05 is printed in bold.

Dependent variables	P		N		C		Sand		Silt	
	cor	p	cor	p	cor	p	cor	p	cor	p
Clay	0.057	0.5	0.11	0.2	0.12	0.1	**-0.49**	**<0.05**	**-0.43**	**<0.05**
Silt	-0.0019	1	-0.13	0.1	-0.2	0.02	**-0.57**	**<0.05**		
Sand	-0.05	0.5	0.026	0.8	0.079	0.3				
C	**0.2**	**<0.05**	**0.74**	**<0.05**						
N	0.12	0.1								

II Results of GLMMs

We performed GLMMs followed by Chi-squared tests to compare the different models for physical (clay, silt, sand) and chemical (C, N, P) soil properties as the predictor variables.

Table S4

Results of the GLMM for clay at each site (Pan de Azúcar, Santa Gracia, La Campana). Depicted are the fixed effects for the predictors, the estimate, the standard error SE and the t- and p-value. Data from both field campaigns were used. Significant effects are labelled with asterisks: *:<0.1, **:<0.01, ***:<0.001.

Fixed effects	Estimate	SE	t	p
(Intercept)	-0.0021	0.0116	-0.18	0.857

Table S5

Results of the GLMM for silt at each site (Pan de Azúcar, Santa Gracia, La Campana). Depicted are the fixed effects for the predictors, the estimate, the standard error SE and the t- and p-value. Data from both field campaigns were used. Significant effects are labelled with asterisks: *:<0.1, **:<0.01, ***:<0.001.

Fixed effects	Estimate	SE	t	p
(Intercept)	-0.0407	0.0684	-0.595	0.553
Slope	0.00328	0.0015	2.19	<0.1 *
Mound density	-0.170	0.105	-1.62	0.109
Site Pan de Azúcar	-0.102	0.0732	-1.40	0.164
Site Santa Gracia	-0.000157	0.077	-0.002	0.998
Mound density: Site Pan de Azúcar	0.256	0.114	2.24	<0.1 *
Mound density: Site Santa Gracia	0.109	0.112	0.971	0.333

Table S6

Results of the GLMM for sand at each site (Pan de Azúcar, Santa Gracia, La Campana). Depicted are the fixed effects for the predictors, the estimate, the standard error SE and the t- and p-value. Data from both field campaigns were used. Significant effects are labelled with asterisks: *:<0.1, **:<0.01, ***:<0.001.

Fixed effects	Estimate	SE	t	p
(Intercept)	0.0185	0.0128	1.45	0.149

Table S7

Results of the GLMM for C at each site (Pan de Azúcar, Santa Gracia, La Campana). Depicted are the fixed effects for the predictors, the estimate, the standard error SE and the t- and p-value. Data from both field campaigns were used. Significant effects are labelled with asterisks: *:<0.1, **:<0.01, ***:<0.001.

Fixed effects	Estimate	SE	t	p
(Intercept)	-1.38	2.39	-0.576	0.566
Site Pan de Azúcar	1.97	2.57	0.767	0.444
Site Santa Gracia	2.08	2.61	0.767	0.427
Mound density	-12.7	2.7	-4.72	<0.001 ***
Vegetation cover	-0.0571	0.0327	-1.75	<0.1 *
Hillslope	0.459	0.0982	4.68	<0.001 ***
Site Pan de Azúcar: Mound density	11.8	2.80	4.21	<0.001 ***
Site Santa Gracia: Mound density	13.2	2.87	4.59	<0.001 ***
Site Pan de Azúcar: Vegetation cover	0.145	0.0580	2.50	<0.1 *
Site Santa Gracia: Vegetation cover	0.0468	0.0457	1.02	0.308
Site Pan de Azúcar: Hillslope	-0.445	0.103	-4.32	<0.001 ***
Site Santa Gracia: Hillslope	-0.477	0.108	-4.39	<0.001 ***

Table S8

Results of the GLMM for N at each site (Pan de Azúcar, Santa Gracia, La Campana). Depicted are the fixed effects for the predictors, the estimate, the standard error SE and the t- and p-value. Data from both field campaigns were used. Significant effects are labelled with asterisks: *:<0.1, **:<0.01, ***:<0.001.

Fixed effects	Estimate	SE	t	p
(Intercept)	0.908	0.231	3.93	<0.001 ***
Site Pan de Azúcar	-0.862	0.237	-3.64	<0.001 ***
Site Santa Gracia	-0.862	0.254	-3.40	<0.001 ***

Vegetation cover	-0.00933	0.00315	-2.97	<0.01 **
Hillside elevation	-0.203	0.0741	-2.74	<0.01 **
Site Pan de Azúcar: Vegetation cover	0.0178	0.00691	2.58	<0.1 *
Site Santa Gracia: Vegetation cover	0.00839	0.00524	1.60	0.112
Site Pan de Azúcar: Hillside elevation	0.225	0.0836	2.69	<0.01 **
Site Santa Gracia: Hillside elevation	0.218	0.0854	2.55	<0.1 *

Table S9

Results of the GLMM for P at each site (Pan de Azúcar, Santa Gracia, La Campana). Depicted are the fixed effects for the predictors, the estimate, the standard error SE and the t- and p-value. Data from both field campaigns were used. Significant effects are labelled with asterisks: *:<0.1, **:<0.01, ***:<0.001.

Fixed effects	**Estimate**	**SE**	**t**	**p**
(Intercept)	0.104	0.0331	3.13	<0.01 **

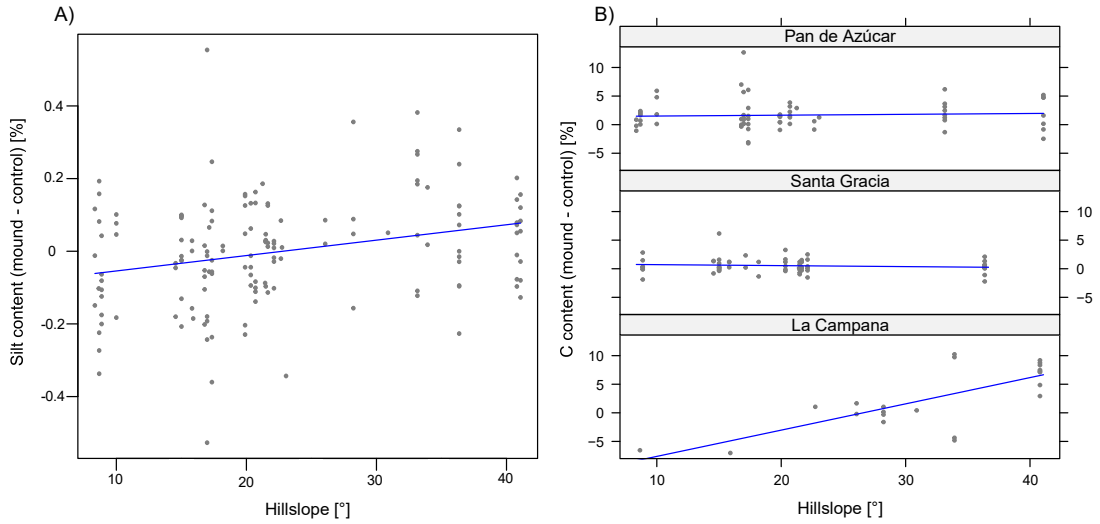

Figure S1. Effect plots for the fixed effect hillslope. A) Fitted relationships between hillslope [°] and silt content [%], B) fitted relationship between hillslope [°] and C content [%] at each research site (Pan de Azúcar, Santa Gracia, La Campana).

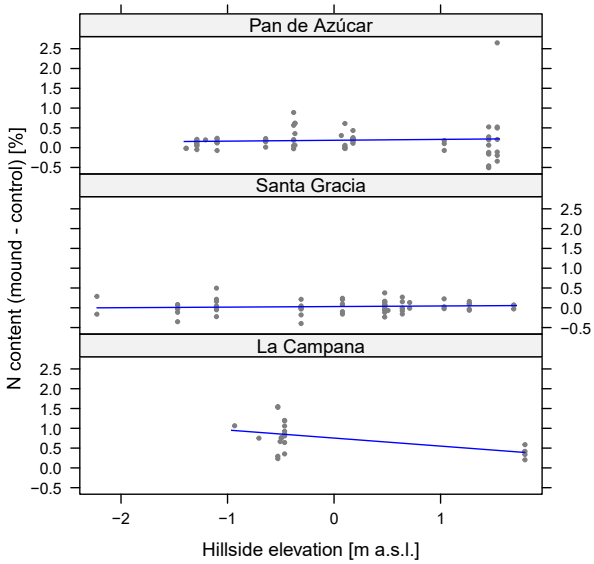

Figure S2. Fitted relationship between N content and the fixed effect hillside elevation [m a.s.l.] at each research site (arid Pan de Azúcar, semi-arid Santa Gracia, Mediterranean La Campana). Note that the x-axis was standardized.

III Literature survey

We compiled a survey of literature on the effects of bioturbation on physical (clay, silt, sand) and chemical (C, N, P) soil properties analyzed in our study.

Table S10

Literature survey of clay, silt, sand, C, N and P contents of mound and undisturbed soils as well as the impact of bioturbation on ecological processes. We give the mean of the different soil properties (clay, silt, sand, C, N, P), the reference, the contents of the soil properties for mound and undisturbed soil samples and the impacts of bioturbation. If necessary, the units were converted to ppm for P and % for all other soil properties. Significantly different values between mound and undisturbed soil are printed bold.

Soil property	Reference	(Zono-) Biome	Mean of mound samples	Mean of control samples	% Input (mound - control)	Impact
Clay [%]	Nkem et al., 2000	III	**29**	**52**	**-79**	Increase of soil porosity
	Eldridge & Koen, 2008	III	23	22	4	Structuring desert landscapes; providing sediment for mobilization
	Mujinya et al., 2010	II	46	39	15	Mixed charge system with higher permanent and variable charges
	Clark et al., 2016	II	7.5	5.4	28	Altering spatial patterning of competitive interactions, plant diversity and productivity; producing ecological ecosystem functioning
	Jouquet et al., 2017	II	**36**	**32**	**11**	Concentration of clay particles below-ground into nests
	Carlson & Whitford, 1991	VII	**1.2**	**2.7**	**-25**	Large gravel mounds heat up quickly due to the lower thermal capacity of coarse fragments and provide insulation

Silt [%]	Nkem et al., 2000	III	**21**	**16**	**24**	Increase of soil porosity; Differential transport of sand-sized particles for the protection of nest entrances
	Eldridge & Koen, 2008	III	65	68	-5	Structuring desert landscapes; providing sediment for mobilization
	Mujinya et al., 2010	II	27	28	-4	Mixed charge system with higher permanent and variable charges
	Clark et al., 2016	II	17	18	-6	Altering spatial patterning of competitive interactions, plant diversity and productivity; producing ecological legacies that affect ecosystem functioning
	Carlson & Whitford, 1991	VII	**16**	**23**	**-44**	large gravel mounds heat up quickly due to the lower thermal coarse fragments and provide insulation
Sand [%]	Nkem et al., 2000	III	**50**	**32**	**36**	Increase of soil porosity
	Eldridge & Koen, 2008	III	12	11	8	Structuring desert landscapes; providing sediment for mobilization
	Mujinya et al., 2010	II	27	33	-22	Mixed charge system with higher permanent and variable charges
	Clark et al., 2016	II	76	77	-1	Altering spatial patterning of competitive interactions, plant diversity and productivity; producing ecological legacies that affect ecosystem functioning; C and N dynamics function much like surface soil when soil moisture is not limiting
	Jouquet et al., 2017	II	58	56	3	Selection and concentration of clay particles below-ground into nests
	Carlson & Whitford, 1991	VII	**82**	**74**	**10**	large gravel mounds heat up quickly due to the lower thermal of coarse fragments and provide insulation
C [%]	Nkem et al., 2000	III	**0.00039**	**0.00032**	**18**	Increase of plant diversity and abundance
	Dostál et al., 2004	VI	**4.2**	**6.4**	**-39**	Support of plant growth and below-ground plant parameters; removal of organic matter from the nests
	Eldridge & Koen, 2008	III	1.5	1.9	-27	Structuring desert landscapes; providing sediment for mobilization; establishment of indigenous plant species
	Clark et al., 2016	II	**0.66**	**1**	**-52**	Altering spatial patterning of competitive interactions, plant diversity and productivity; producing ecological legacies that affect ecosystem functioning; C and N dynamics function much like surface soil when soil moisture is not limiting
	Jouquet et al., 2017	II	**2.7**	**0.79**	**71**	C and N are incorporated into termite construction
	Yurkewycz et al., 2014	IV	0.00064	0.00058	9	Soil development is enhanced due to increased C and N, progressing soil and vegetation heterogeneity at small scales
N [%]	Dostál et al., 2004	VI	**0.30**	**0.58**	**-93**	Support of plant growth and below-ground plant parameters; removal of organic matter from the nests
	Eldridge & Koen, 2008	III	0.11	0.16	-45	Structuring desert landscapes; providing sediment for mobilization; establishment of indigenous plant species
	Clark et al., 2016	II	0.07	0.11	-57	Altering spatial patterning of competitive interactions, plant diversity and productivity; producing ecological legacies that affect ecosystem functioning; C and N dynamics function much like surface soil when soil moisture is not limiting
	Jouquet et al., 2017	II	**0.21**	**0.09**	**57**	C and N are incorporated into termite construction

	Yurkewycz et al., 2014	IV	0.051	0.047	8	Soil development is enhanced due to increased C and N, progressing soil and vegetation heterogeneity at small scales
P [ppm]	Nkem et al., 2000	III	**100.2**	**27.9**	**72**	Increase of plant diversity and abundance
	Dostál et al., 2004	VI	23.37	15.46	34	Support plant growth and below-ground plant parameters; increased decomposition rate
	Eldridge & Koen, 2008	III	**137.5**	**171.5**	**25**	Structuring desert landscapes; providing sediment for mobilization
	Carlson & Whitford, 1991	VII	**19.3**	**1.5**	**92**	relative nutrient enrichment

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