Supplementary Information

Supplementary Methods

To expand on our analyses of the effects of microclimate and distance from buffer-oil-palm edge on dung beetle Shannon diversity in riparian buffers, we also investigated how species richness varied across our landscape. Using the same dung beetle community data, we ran generalised linear models (GLMs) of species richness with Poisson error structure in *lme4* (Bates et al., 2015). Models were then subsetted using AIC weight following methods described for Shannon diversity in the main text. Models of Shannon diversity and species richness were also checked for leverage using Cook's distances in *influence.ME* (Nieuwenhuis et al., 2012).

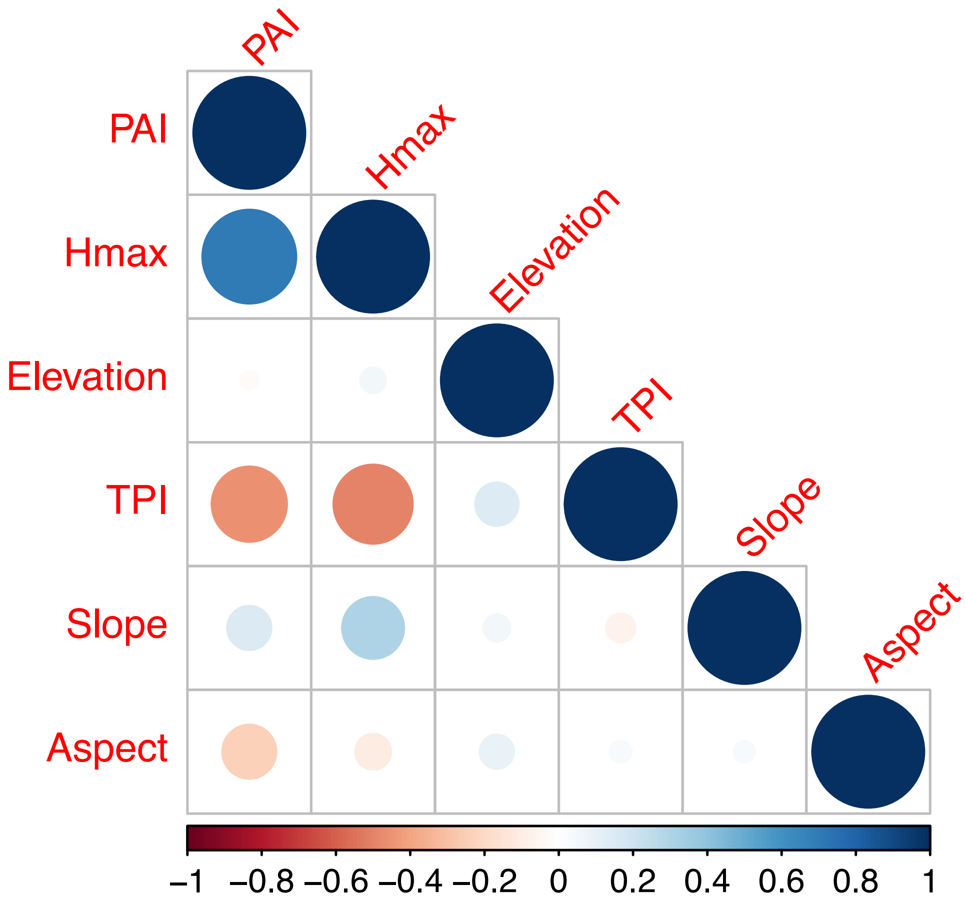
Supplementary Results

Species richness responded to microclimate and distance to edge in a similar manner to Shannon diversity. The interaction term between distance from edge and each of our 4 microclimate variables was retained in the best fitting models (Supplementary Table 3). That said, additive models of distance from edge and microclimate, and models of only distance from edge, were also retained in all sets of best-fitting models (Supplementary Table 3). Additionally, all best-fitting model sets also retained a model with only microclimate as an explanatory variable, with the exception of those for T_{mean} (Supplementary Table 3). Our results suggest that dung beetle species richness decreases with proximity-to-edge and each of our 4 microclimatic variables (Supplementary Table 4). The null model was not retained in the best-fitting models for all microclimate variables (Supplementary Table 3). Maximum Cook's distance for all models of species richness was below 0.5.

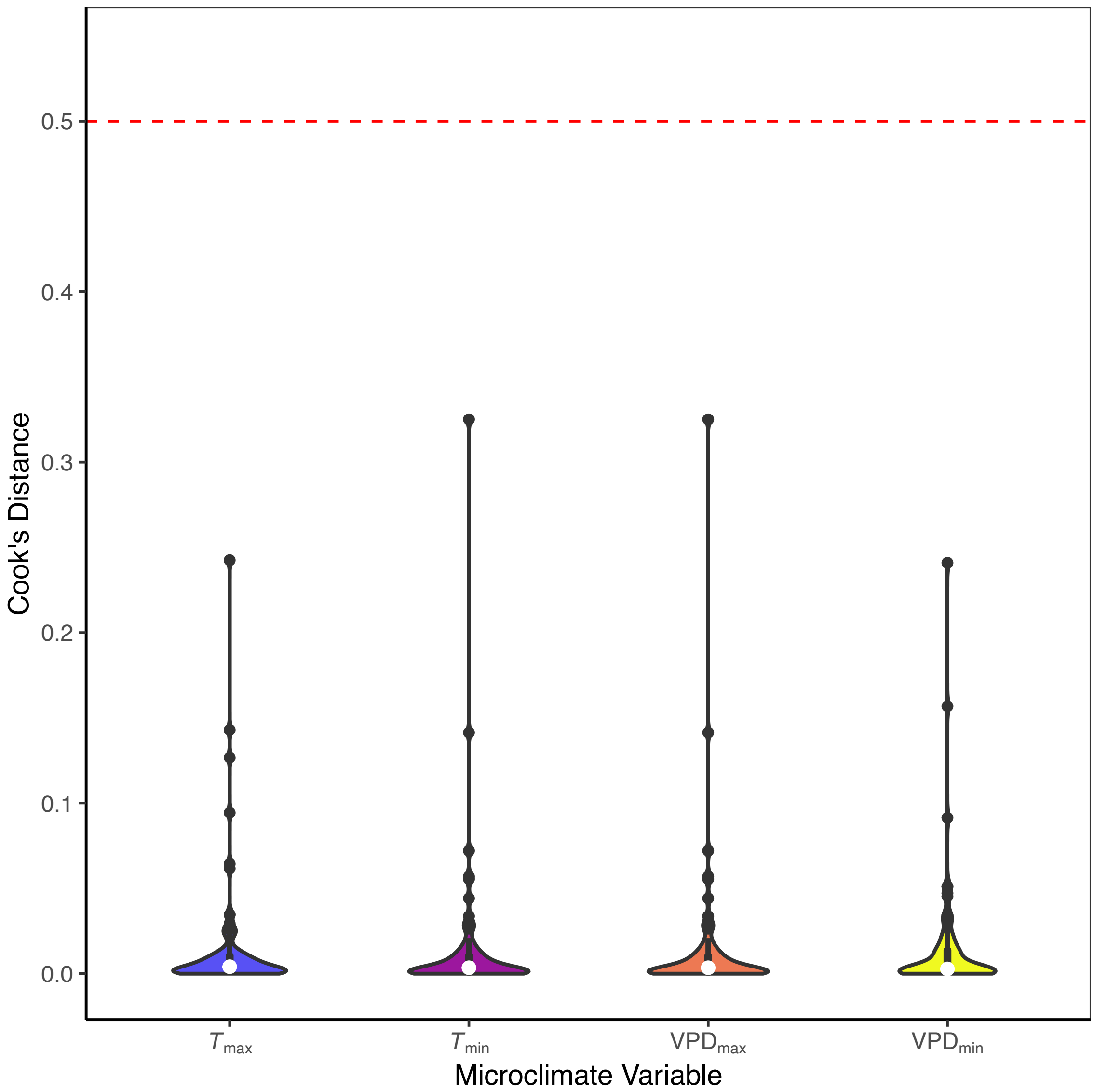
Supplementary References

Bates, D., Maechler. M, Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1), 1-48.

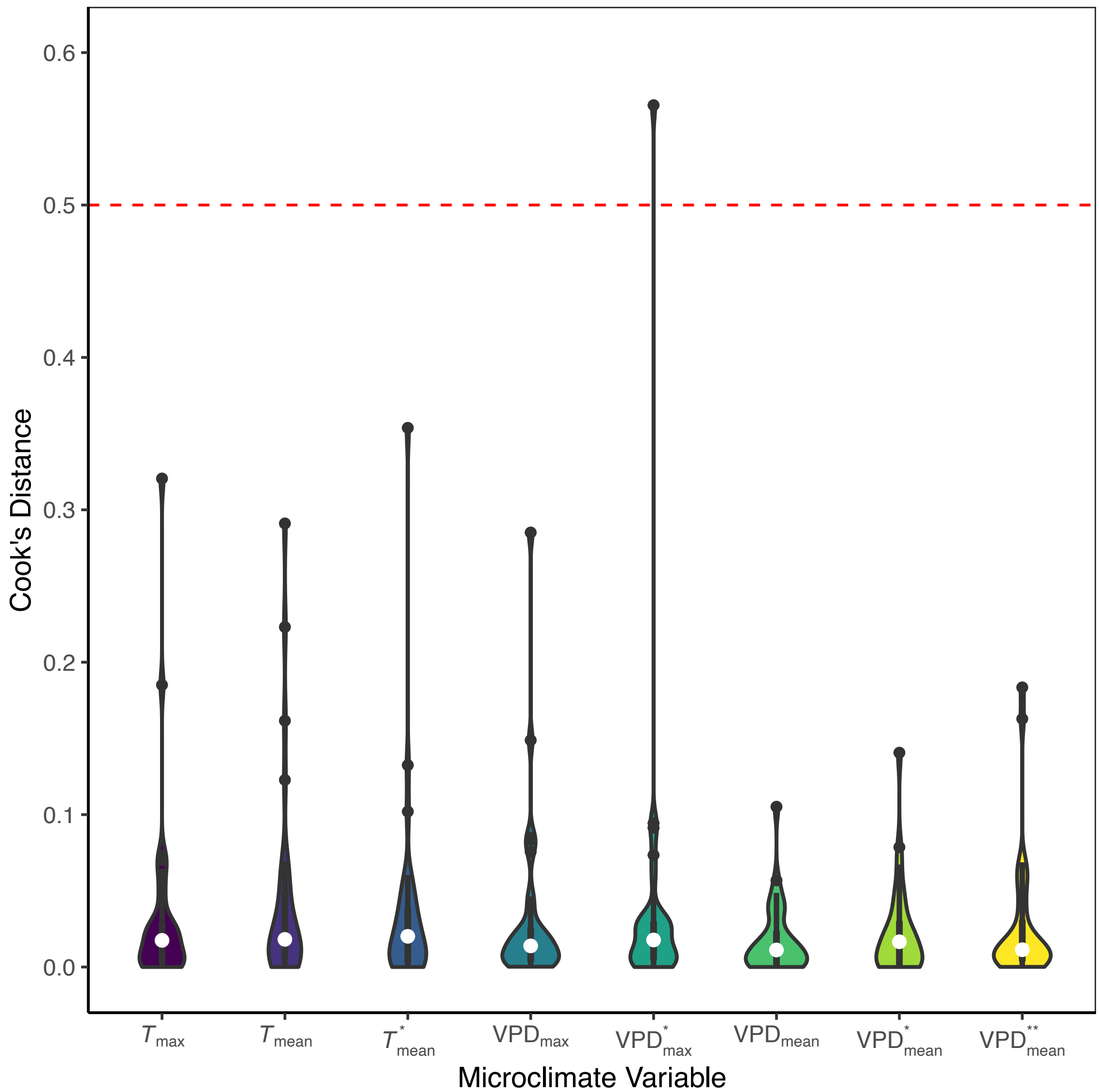
Nieuwenhuis, R., Te Grotenhuis, H.F. & Pelzer, B.J. (2012). influence.ME: tools for detecting influential data in mixed effects models. *The R Journal*, *4*(2), 38-47.



Supplementary Figure 1 - A correlation plot of LiDAR-derived variables of mean plant area index (PAI, log-transformed), maximum canopy height (H_{max}), topographic position index (TPI), elevation, aspect and slope.



Supplementary Figure 2 - A violin plot of the Cook's distances of all points used in distance from buffer edge analyses (see Figure 4). Cook's distance measures the relative influence of each point on model fit to check for poorly-fit models. All values are below the threshold value of 0.5 denoted by the dashed red line.



Supplementary Figure 3 - A violin plot of the Cook's distances of all points used in Shannon diversity analyses (see Figure 5). Labels on the x-axis with a single asterisk denote models lacking the interaction term between the microclimate variable of interest and distance from edge into buffer, 2 asterisks denote a model containing only distance from edge into buffer as a fixed effect. Cook's distance measures the relative influence of each point on model fit to check for poorly-fit models. One value in the VPD_{max} model lacking an interaction term was greater than the Cook's distance threshold of 0.5 (denoted by a red, dashed line).

Supplementary Table 1 - A table summarising the sample sizes of rivers, transects and dataloggers by habitat type. Columns on the left are total numbers and columns on the right are sample sizes from the LiDAR-based analyses of vegetation quality and topographic features. Note that 'riparian buffer' transects were composed of 3 points within the riparian buffer and 2 within oil palm habitats, resulting in a high number of oil palm dataloggers relative to oil palm transects. One continuous forest river within the LiDAR area was dropped from analyses due to inaccurate GPS coordinates.

	Total			**LiDAR**		
Habitat Type	**Rivers**	**Transects**	**Dataloggers**	**Rivers**	**Transects**	**Dataloggers**
Continuous Forest	2	6	27	1	3	14
Riparian Buffer	16	42	82	8	20	52
Oil Palm	2	6	85	2	5	54
Total	20	54	198	13	31	110

***Supplementary Table 2* -** A correlation matrix of the four microclimatic variables. Values given are Pearson's *r*.

	T_{max}	T_{mean}	VPD_{max}	VPD_{mean}
VPD_{mean}	0.685	0.752	0.766	1
VPD_{max}	0.914	0.624	1	
T_{mean}	0.724	1		
T_{max}	1			

***Supplementary Table 3* - ** AIC weights of all models of species richness for each microclimatic variable (T_{max}, T_{mean}, VPD_{max} and VPD_{mean}), where 'interaction' denotes models containing the interaction term between buffer width and microclimate, 'additive' denotes a model containing microclimate and buffer width, 'buffer width' and 'microclimate' denote models containing only that term, and 'null' is the null model. Values given in bold make up the best-fitting models, as calculated by a cumulative ranked weight > 0.95.

models	$\boldsymbol{T_{max}}$	$\boldsymbol{T_{mean}}$	$\mathbf{VPD_{max}}$	$\mathbf{VPD_{mean}}$
interaction	**0.531**	**0.530**	**0.331**	**0.219**
additive	**0.316**	**0.207**	**0.432**	**0.406**
buffer width	**0.097**	**0.228**	**0.070**	**0.055**
microclimate	**0.051**	0.025	**0.164**	**0.317**
null	0.005	0.011	0.003	0.001

Supplementary Table 4 **-** Outputs of best-fitting generalised linear models predicting the species richness (*S*) of dung beetles sampled in riparian buffers. In the model column '~' means 'as a function of', '*' means the two terms individually and the interaction between the two are included.

model	term	estimate	SE
$S \sim T_{max}$ * distance from edge	intercept	8.136	3.406
	T_{max}	-0.205	0.104
	distance from edge	-1.300	0.883
	T_{max} : distance from edge	0.046	0.027
$S \sim T_{max}$ + distance from edge	intercept	2.516	0.691
	T_{max}	-0.032	0.016
	distance from edge	0.198	0.082
$S \sim T_{max}$	intercept	3.510	0.547
	T_{max}	-0.040	0.016
$S \sim T_{mean}$ * distance from edge	intercept	28.467	12.822
	T_{mean}	-1.101	0.521
	distance from edge	-5.940	3.171
	T_{mean} : distance from edge	0.250	0.129
$S \sim T_{mean}$ + distance from edge	intercept	4.053	2.122
	T_{mean}	-0.109	0.081
	distance from edge	0.211	0.084

S ~ VPD_{max} * distance from edge	intercept	2.437	0.656
	VPD_{max}	-0.051	0.032
	distance from edge	0.001	0.157
	VPD_{max} : distance from edge	0.010	0.009
S ~ VPD_{max} + distance from edge	intercept	1.822	0.392
	VPD_{max}	-0.014	0.006
	distance from edge	0.170	0.085
S ~ VPD_{max}	intercept	2.539	0.141
	VPD_{max}	-0.017	0.005
S ~ VPD_{mean} * distance from edge	intercept	2.144	0.517
	VPD_{mean}	-0.278	0.208
	distance from edge	0.068	0.126
	VPD_{mean} : distance from edge	0.048	0.056
S ~ VPD_{mean} + distance from edge	intercept	1.868	0.400
	VPD_{mean}	-0.105	0.044
	distance from edge	0.142	0.090

$S \sim VPD_{mean}$	intercept	2.469	0.111
	VPD_{mean}	-0.133	0.041
S ~ distance from edge	intercept	1.254	0.321
	distance from edge	0.237	0.082