Science Advances
AAAS

advances.sciencemag.org/cgi/content/full/5/9/eaau6635/DC1

Supplementary Materials for

Decadal-scale shifts in soil hydraulic properties as induced by altered precipitation

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Published 11 September 2019, *Sci. Adv.* **5**, eaau6635 (2019)
DOI: 10.1126/sciadv.aau6635

This PDF file includes:

Supplementary Figures

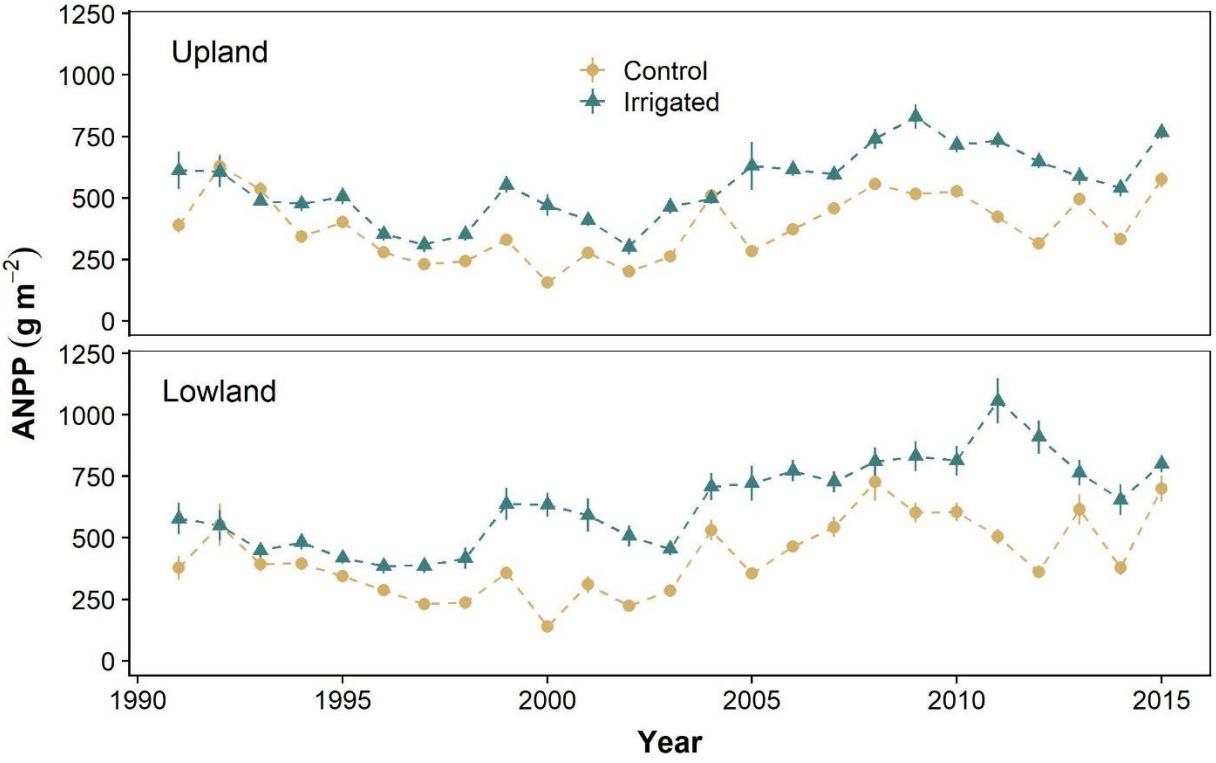

Fig. S1. Aboveground net primary productivity. Shown are means and standard errors (SE) across six plots in upland and lowland landscape positions on each transect; each plot contained six replicate subplots that were averaged to derive plot-level values.

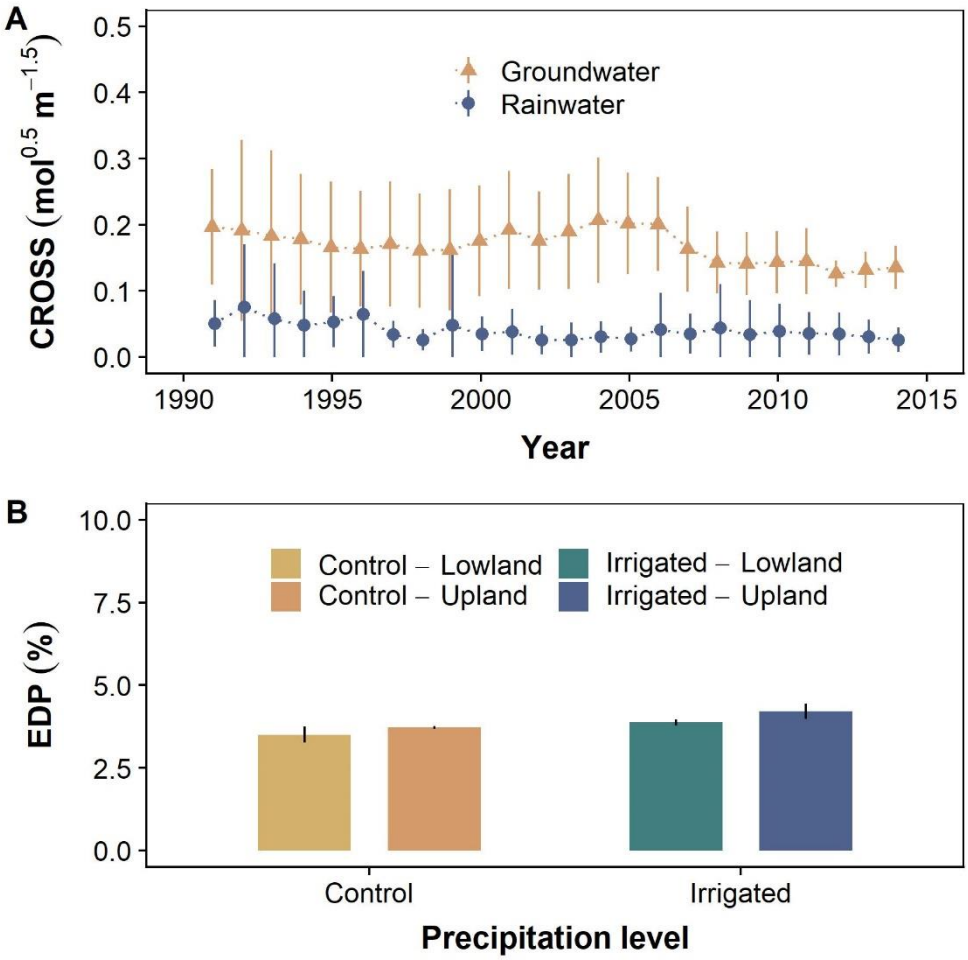

Fig. S2. Metrics of cation dispersive capacity. (A) Cation ratio of soil structural stability (CROSS) for groundwater and rainwater at the Konza Prairie Biological Station (mean ± standard deviation across all samples collected each year). (B) Exchangeable dispersive percentage (EDP; mean ± SE across plot pairs) for soils sampled during this study.

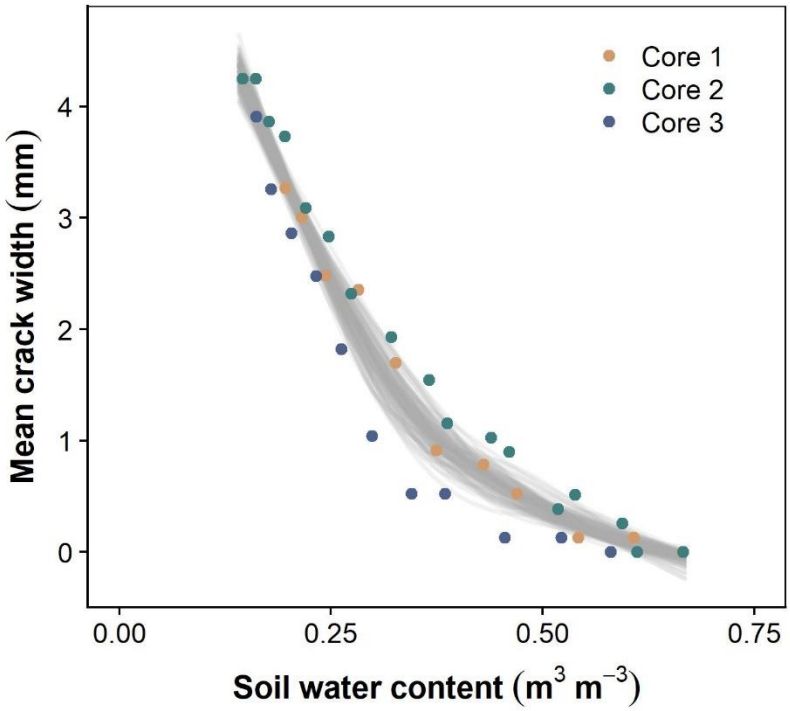

Fig. S3. Relationship between soil crack widths and water content. Data come from three cores that were imaged and weighed in the laboratory as they dried. Smoothing splines fit to bootstrapped data (grey lines) were used to translate time series data of volumetric water content (Fig. 1C) into a distribution of crack sizes (Fig. 5C).

Supplementary Tables

Table S1. Plant community composition of Konza Prairie's Irrigation Transect Experiment when the analysis of soil hydraulic properties was conducted. Cover values are relativized to the total cover across all plots in the respective water regime. Fine-root diameters used in computing the community-weighted mean are also shown; values are geometric means of all pertinent root diameter records. Asterisks denote species for which only genus-level data were available.

Species name	Relative cover - Control -	Relative cover - Irrigated -	Root diameter (mm)	Number of records
Ambrosia psilostachya	0.2%	0.2%	0.360	1*
Amorpha canescens	4.2%	6.8%	0.194	1
Andropogon gerardii	56.8%	29.0%	0.212	4
Asclepias verticillata	0.5%	0.2%	0.422	5
Bouteloua curtipendula	1.4%	1.4%	0.175	16
Brickellia eupatorioides	0.3%	1.0%		
Carex inops	1.5%	0.1%	0.418	55*
Carex meadii	1.8%	0.6%	0.418	55*
Chamaecrista fasciculata	0.5%	0.2%	0.253	9
Cornus drummondii	2.1%	0.0%	0.748	1*
Croton monanthogynus	0.0%	0.1%		
Dalea candida	0.8%	0.2%	0.306	7
Desmanthus illinoensis	0.0%	9.7%	0.270	9
Dichanthelium oligosanthes	0.5%	0.3%		
Eragrostis spectabilis	0.3%	0.1%	0.210	1*
Eupatorium altissimum	0.0%	0.1%	0.346	9
Euphorbia nutans	0.2%	0.0%	0.195	2
Helianthus pauciflorus	0.0%	0.7%	0.360	1
Lespedeza capitata	0.0%	0.3%	0.306	6
Linum sulcatum	1.3%	0.0%		
Mimosa nuttallii	0.0%	1.8%		
Panicum virgatum	10.5%	32.4%	0.229	10
Physalis pumila	0.3%	0.1%	0.300	1*
Rosa arkansana	1.1%	0.1%	0.306	1
Ruellia humilis	1.0%	0.6%	0.428	14
Salvia azurea	1.7%	0.8%	0.335	12
Schizachyrium scoparium	4.2%	1.8%	0.216	17
Solidago canadensis	1.3%	2.4%	0.205	5
Solidago missouriensis	0.5%	2.4%	0.291	2
Sorghastrum nutans	4.8%	3.7%	0.237	20
Sporobolus asper	1.1%	1.8%	0.332	3*
Symphyotrichum ericoides	0.8%	0.3%	0.318	2
Teucrium canadense	0.2%	0.3%	0.313	2*
Vernonia baldwinii	0.3%	0.2%	0.325	9

Table S2. Statistical modeling summary for infiltration rate. Model-level descriptors are shown at left, including the attribute defining the data used as the response variable ($Data_{res}$), the mean R^2 of model variants with $\Delta AIC_c < 2$, the number of observations in the dataset (N_{obs}), and the number of model variants used for model averaging (those with $\Delta AIC_c < 6$). Term-level descriptors are shown at right, including the name of the term (Term), the standardized coefficient determined by model averaging, the standard error of the coefficient (SE), and the 95% confidence interval of the coefficient (95% CI). *h*, pressure potential, *Posn*, landscape position; *Regm*, precipitation regime.

Model				**Terms**			
$Data_{res}$	R^2	N_{obs}	N_{mod}	Term	Coef	SE	95% CI
h = -0.5 hPa	0.42	91	4	Posn	-0.012	0.042	(-0.094, 0.069)
				Regm	0.001	0.041	(-0.081, 0.082)
h = -1.5 hPa	0.38	94	5	Posn	-0.003	0.038	(-0.077, 0.070)
				Regm	-0.086	0.091	(-0.265, 0.094)
				Posn × Regm	0.000	0.028	(-0.054, 0.054)
h = -2.5 hPa	0.38	94	5	Posn	0.019	0.050	(-0.079, 0.116)
				Regm	-0.150	0.100	(-0.347, 0.046)
				Posn × Regm	0.002	0.038	(-0.072, 0.076)
h = -3.5 hPa	0.36	91	5	Posn	0.107	0.092	(-0.073, 0.286)
				Regm	-0.219	0.106	(-0.428, -0.010)
				Posn × Regm	0.027	0.085	(-0.140, 0.193)
h = -5.5 hPa	0.29	92	5	Posn	0.026	0.059	(-0.091, 0.143)
				Regm	-0.184	0.106	(-0.391, 0.023)
				Posn × Regm	0.002	0.044	(-0.083, 0.088)

Table S3. Statistical modeling summary for various soil properties. Model-level descriptors are shown at left, including the data used as the response variable ($Data_{res}$), the mean R^2 of model variants with $\Delta AIC_c < 2$, the number of observations in the dataset (N_{obs}), and the number of model variants used for model averaging (those with $\Delta AIC_c < 6$). Term-level descriptors are shown at right, including the name of the term (Term), the standardized coefficient determined by model averaging (Coef), the standard error of the coefficient (SE), and the 95% confidence interval of the coefficient (95% CI). Abbreviations are defined in table S2; additionally *EDP*, exchangeable dispersive percentage.

Model				**Terms**			
$Data_{res}$	R^2	N_{obs}	N_{mod}	Term	Coef	SE	95% CI
Porosity	0.74	8	1	Posn	0.08	0.17	(-0.248, 0.410)
				Regm	0.52	0.17	(0.195, 0.852)
				Posn × Regm	-1.22	0.34	(-1.873, -0.557)
Carbon	0.26	72	4	Posn	0.90	0.28	(0.363, 1.444)
				Regm	0.07	0.19	(-0.299, 0.435)
				Posn × Regm	-0.01	0.12	(-0.240, 0.213)
Nitrogen	0.37	72	3	Posn	1.16	0.18	(0.798, 1.518)
				Regm	0.06	0.17	(-0.276, 0.386)
				Posn × Regm	-0.01	0.10	(-0.217, 0.194)
EDP	0.12	24	4	Posn	-0.15	0.31	(-0.458, 0.750)
				Regm	0.43	0.50	(-0.548, 1.409)

Table S4. Statistical modeling summary for water retention. Model-level descriptors are shown at left, including the attribute defining the data used as the response variable ($Data_{res}$), the mean R^2 of model variants with $\Delta AIC_c < 2$, the number of observations in the dataset (N_{obs}), and the number of model variants used for model averaging (those with $\Delta AIC_c < 6$). Term-level descriptors are shown at right, including the name of the term (Term), the standardized coefficient determined by model averaging (Coef), the standard error of the coefficient (SE), and the 95% confidence interval of the coefficient (95% CI). Abbreviations are defined in table S2.

Model				Terms			
$Data_{res}$	R^2	N_{obs}	N_{mod}	Term	Coef	SE	95% CI
pF = 0.5 - 1	0.94	176	5	pF	-0.630	0.015	(-0.659, -0.601)
				Posn	-0.037	0.177	(-0.384, 0.311)
				Regm	0.131	0.172	(-0.206, 0.469)
				pF × Posn	0.199	0.029	(0.141, 0.257)
				pF × Regm	0.040	0.032	(-0.023, 0.103)
				Posn × Regm	0.348	0.360	(-0.357, 1.053)
				pF × Posn × Regm	0.123	0.089	(-0.050, 0.297)
pF = 1 - 1.5	0.98	176	1	pF	-0.816	0.009	(-0.832, -0.799)
				Posn	0.224	0.116	(-0.003, 0.451)
				Regm	0.208	0.116	(-0.019, 0.434)
				pF × Posn	0.132	0.017	(0.099, 0.165)
				pF × Regm	0.058	0.017	(0.024, 0.091)
				Posn × Regm	0.144	0.231	(-0.309, 0.598)
				pF × Posn × Regm	-0.239	0.034	(-0.306, -0.172)
pF = 1.5 - 2	0.99	176	5	pF	-0.695	0.006	(-0.706, -0.683)
				Posn	0.412	0.133	(0.152, 0.672)
				Regm	0.244	0.137	(-0.025, 0.513)
				pF × Posn	0.051	0.011	(0.029, 0.074)
				pF × Regm	-0.027	0.014	(-0.054, 0.000)
				Posn × Regm	0.006	0.161	(-0.309, 0.321)
				pF × Posn × Regm	0.007	0.017	(-0.027, 0.041)

pF = 2 - 2.5	0.98	176	4	pF	-0.703	0.009	(-0.721, -0.685)
				Posn	0.467	0.122	(0.228, 0.706)
				Regm	0.180	0.122	(-0.059, 0.419)
				pF × Posn	0.019	0.019	(-0.018, 0.055)
				pF × Regm	-0.072	0.018	(-0.108, -0.036)
				Posn × Regm	0.088	0.220	(-0.344, 0.519)
				pF × Posn × Regm	0.079	0.057	(-0.033, 0.191)
pF = 2.5 - 3	0.98	176	1	pF	-0.801	0.008	(-0.817, -0.785)
				Posn	0.344	0.102	(0.144, 0.545)
				Regm	0.121	0.102	(-0.080, 0.322)
				pF × Posn	-0.158	0.016	(-0.190, -0.126)
				pF × Regm	-0.005	0.016	(-0.037, 0.027)
				Posn × Regm	0.328	0.205	(-0.074, 0.729)
				pF × Posn × Regm	0.203	0.033	(0.140, 0.267)
pF = 3 - 3.5	0.98	176	6	pF	-0.672	0.009	(-0.689, -0.655)
				Posn	0.306	0.158	(-0.003, 0.616)
				Regm	0.089	0.143	(-0.191, 0.37)
				pF × Posn	0.001	0.009	(-0.018, 0.019)
				pF × Regm	-0.075	0.018	(-0.110, -0.041)
				Posn × Regm	0.478	0.363	(-0.233, 1.189)
				pF × Posn × Regm	-0.002	0.011	(-0.024, 0.021)
pF = 3.5 - 4	0.96	176	1	pF	-0.725	0.013	(-0.749, -0.700)
				Posn	0.255	0.129	(0.002, 0.508)
				Regm	-0.125	0.129	(-0.377, 0.128)
				pF × Posn	-0.161	0.025	(-0.211, -0.111)
				pF × Regm	-0.171	0.025	(-0.221, -0.121)
				Posn × Regm	0.230	0.258	(-0.275, 0.735)
				pF × Posn × Regm	-0.540	0.051	(-0.639, -0.440)

Table S5. Statistical modeling summary for root diameter, computed as the community-weighted mean during each year of the experiment (Fig. 4) and analyzed in 5 yr increments. Model-level descriptors are shown at left, including the data used as the response variable ($Data_{res}$), the mean R^2 of model variants with $\Delta AIC_c < 2$, the number of observations in the dataset (N_{obs}), and the number of model variants used for model averaging (those with $\Delta AIC_c < 6$). Term-level descriptors are shown at right, including the name of the term (Term), the standardized coefficient determined by model averaging (Coef), the standard error of the coefficient (SE), and the 95% confidence interval of the coefficient (95% CI). Abbreviations are defined in table S2.

Model				**Terms**			
$Data_{res}$	R^2	N_{obs}	N_{mod}	Term	Coef	SE	95% CI
Years 1991-1995	0.53	180	5	Posn	-0.069	0.122	(-0.309, 0.170)
				Regm	0.007	0.075	(-0.141, 0.155)
				Posn × Regm	-0.005	0.058	(-0.119, 0.109)
Years 1996-2000	0.75	240	5	Posn	-0.101	0.139	(-0.373, 0.171)
				Regm	0.030	0.089	(-0.143, 0.204)
				Posn × Regm	-0.004	0.062	(-0.125, 0.117)
Years 2001-2005	0.72	240	5	Posn	0.286	0.168	(-0.043, 0.616)
				Regm	0.186	0.150	(-0.107, 0.480)
				Posn × Regm	0.002	0.099	(-0.191, 0.196)
Years 2006-2010	0.68	240	5	Posn	0.078	0.123	(-0.163, 0.320)
				Regm	-0.005	0.073	(-0.148, 0.138)
				Posn × Regm	0.005	0.057	(-0.108, 0.117)
Years 2011-2015	0.59	240	4	Posn	0.325	0.145	(0.042, 0.609)
				Regm	0.029	0.081	(-0.130, 0.188)
				Posn × Regm	0.012	0.083	(-0.151, 0.174)

Table S6. Statistical modeling summary for soil aggregates and particles. Model-level descriptors are shown at left, including the attribute defining the data used as the response variable ($Data_{res}$), the mean R^2 of model variants with $\Delta AIC_c < 2$, the number of observations in the dataset (N_{obs}), and the number of model variants used for model averaging (those with $\Delta AIC_c < 6$). Term-level descriptors are shown at right, including the name and transformation of the term (Term), the standardized coefficient determined by model averaging (Coef), the standard error of the coefficient (SE), and the 95% confidence interval of the coefficient (95% CI). Abbreviations are defined in table S2; additionally *Diam*, particle diameter.

Model				**Terms**			
$Data_{res}$	R^2	N_{obs}	N_{mod}	Term	Coef	SE	95% CI
Ø = 0.1-1 µm	0.87	1464	5	log(Diam)	0.937	0.010	(0.917, 0.957)
				Posn	-0.060	0.015	(-0.089, -0.032)
				Regm	-0.046	0.015	(-0.075, -0.018)
				log(Diam) × Posn	-0.131	0.019	(-0.168, -0.094)
				log(Diam) × Regm	-0.041	0.023	(-0.086, 0.004)
				Posn × Regm	0.000	0.017	(-0.033, 0.033)
				log(Diam) × Posn × Regm	0.002	0.013	(-0.023, 0.027)
Ø = 1-10 µm	0.95	1800	3	log(Diam)	0.894	0.005	(0.884, 0.904)
				Posn	-0.238	0.054	(-0.343, -0.132)
				Regm	-0.107	0.054	(-0.212, -0.001)
				log(Diam) × Posn	-0.106	0.010	(-0.126, -0.086)
				log(Diam) × Regm	-0.073	0.010	(-0.093, -0.053)
				Posn × Regm	0.009	0.064	(-0.117, 0.134)
				log(Diam) × Posn × Regm	-0.001	0.007	(-0.014, 0.013)
Ø = 10-100 µm	0.72	1728	3	log(Diam)	0.835	0.013	(0.811, 0.86)
				Posn	0.096	0.013	(0.070, 0.121)
				Regm	0.040	0.013	(0.015, 0.065)
				log(Diam) × Posn	0.142	0.025	(0.092, 0.191)
				log(Diam) × Regm	0.110	0.025	(0.061, 0.160)
				Posn × Regm	-0.028	0.028	(-0.084, 0.028)
				log(Diam) × Posn × Regm	-0.008	0.028	(-0.063, 0.047)

Table S6 (continued).

Model				Terms			
$Data_{res}$	R^2	N_{obs}	N_{mod}	Term	Coef	SE	95% CI
Ø = 100-1000 µm	0.65	1800	13	log(Diam)	-0.802	0.014	(-0.829, -0.774)
				Posn	-0.026	0.024	(-0.074, 0.021)
				Regm	-0.005	0.015	(-0.034, 0.024)
				log(Diam) × Posn	0.008	0.020	(-0.030, 0.047)
				log(Diam) × Regm	-0.001	0.010	(-0.021, 0.019)
				Posn × Regm	0.005	0.020	(-0.034, 0.044)

Table S7. Statistical modeling summary for aggregate stability. Model-level descriptors are shown at left, including the attribute defining the data used as the response variable ($Data_{res}$), the mean R^2 of model variants with $\Delta AIC_c < 2$, the number of observations in the dataset (N_{obs}), and the number of model variants used for model averaging (those with $\Delta AIC_c < 6$). Term-level descriptors are shown at right, including the name of the term (Term), the standardized coefficient determined by model averaging (Coef), the standard error of the coefficient (SE), and the 95% confidence interval of the coefficient (95% CI). Abbreviations are defined in table S2. Empty cells indicate that no model variant had an AIC_c within 6 points of the intercept-only model.

Model				Terms			
$Data_{res}$	R^2	N_{obs}	N_{mod}	Term	Coef	SE	95% CI
2 mm mesh	0.00	15	1	-	-	-	-
1 mm mesh	0.03	16	2	Regm	-0.02	0.15	(-0.311, 0.269)
0.25 mm mesh	0.02	16	2	Posn	-0.05	0.22	(-0.474, 0.384)
0.053 mm mesh	0.00	16	1	-	-	-	-

Table S8. Aggregate stability, measured as the percentage of aggregate mass retained by a sieve before vs. after agitation in water.

Sieve size	Water regime	Landscape position	Percent retained
2 mm	Control	Lowland	92.5 ± 0.3
		Upland	91.2 ± 0.3
	Irrigated	Lowland	90.6 ± 0.7
		Upland	92.0 ± 1.6
1 mm	Control	Lowland	94.8 ± 0.4
		Upland	93.9 ± 0.9
	Irrigated	Lowland	93.4 ± 0.7
		Upland	93.4 ± 2.2
0.25 mm	Control	Lowland	97.4 ± 0.5
		Upland	95.9 ± 0.8
	Irrigated	Lowland	96.2 ± 0.4
		Upland	96.2 ± 0.3
0.053 mm	Control	Lowland	98.2 ± 0.5
		Upland	98.0 ± 0.4
	Irrigated	Lowland	98.0 ± 0.3
		Upland	98.0 ± 0.3