Supplementary information

Damage costs from invasive species exceed management expenditure in nations experiencing lower economic activity

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Appendix 1. Additional data relationships

Fig. S1. No relationship between annual costs (left panel: damage costs; right panel: management expenditure) and number of reported genera.

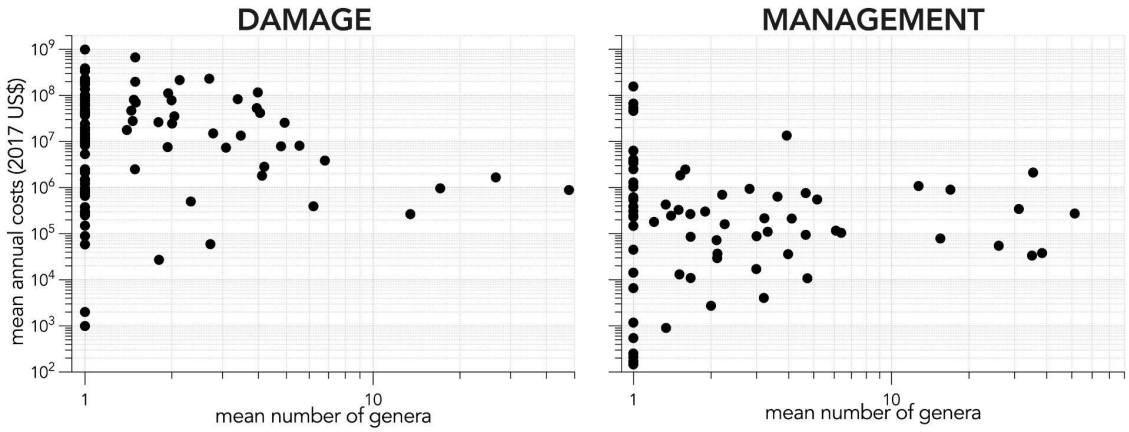


Fig. S2. Correlation (Kendall's τ) matrix heatmap for the scaled, transformed predictor variables used in subsequent analyses. $|\tau|_{median} = 0.41$; $|\tau|_{max} = 0.79$. **GDP** = per-capita gross domestic product; **GHSI** = global health security index; **IGS** = per-capita imports of goods and services; **CPI** = corruption perception index; **VAPP** = value-added %GDP from primary production (agriculture, fisheries, and forestry); **AGRL** = proportion of terrestrial land area devoted to agriculture; **STJA** = per-capita production of scientific and technical journal articles; **EDU** = government investment in education (proportion of gross domestic product). A numeric matrix version of this heatmap is provided in Table S1.

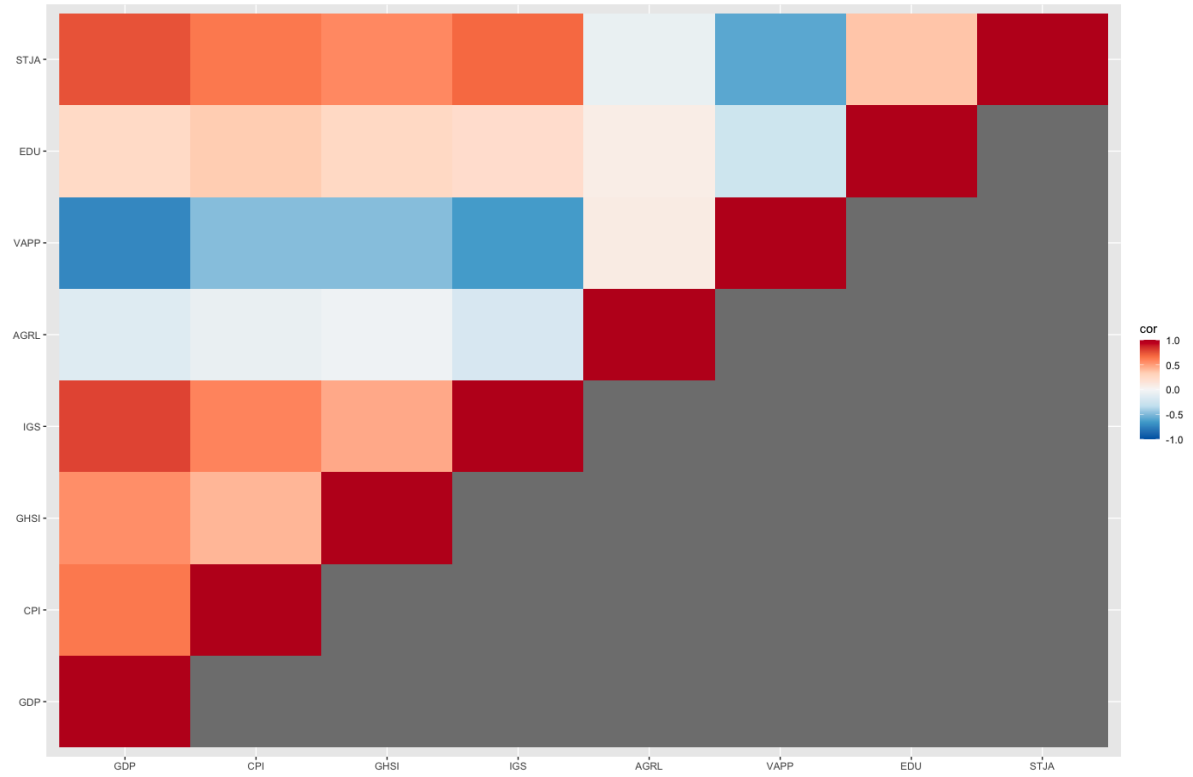
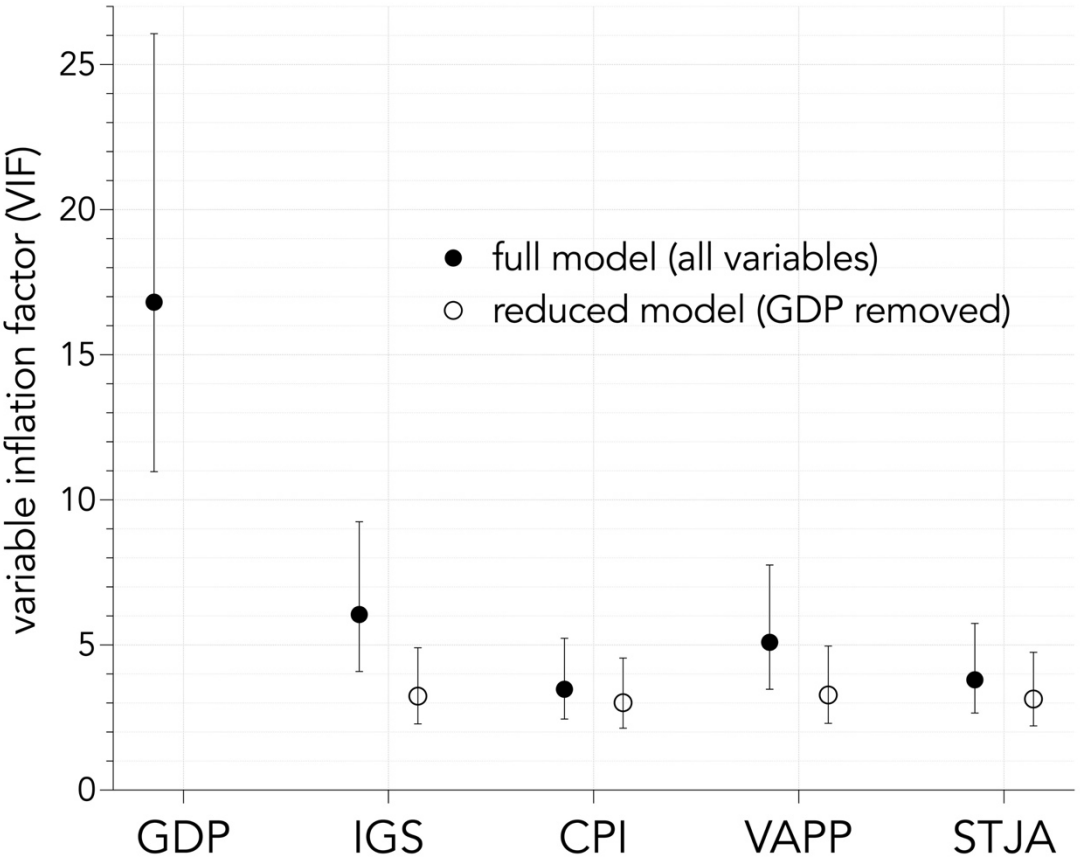


Table. S1. Correlation (Kendall's τ) matrix for the scaled, transformed predictor variables used in subsequent analyses. $|\tau|_{median} = 0.41$; $|\tau|_{max} = 0.79$. **GDP** = per-capita gross domestic product; **GHSI** = global health security index; **IGS** = per-capita imports of goods and services; **CPI** = corruption perception index; **VAPP** = value-added %GDP from primary production (agriculture, fisheries, and forestry); **AGRL** = proportion of terrestrial land area devoted to agriculture; **STJA** = per-capita production of scientific and technical journal articles; **EDU** = government investment in education (proportion of gross domestic product). A colour-scale heatmap version of this matrix is provided in Fig. S2.

	GDP	CPI	GHSI	IGS	AGRL	VAPP	EDU
STJA	0.747	0.631	0.574	0.681	-0.081	-0.612	0.366
EDU	0.253	0.347	0.216	0.216	0.078	-0.251	
VAPP	-0.753	-0.495	-0.484	-0.669	0.116		
AGRL	-0.147	-0.083	-0.042	-0.195			
IGS	0.788	0.589	0.460				
GHSI	0.555	0.419					
CPI	0.631						

Appendix 2. Collinearity

Fig. S3. Variance inflation factor calculated using the *check_collinearity* function in the performance library (Lüdecke et al., 2021) in R (R Core Team, 2023) for the full general linear mixed-effects model of the relationship between the ratio of damage cost to management expenditure among countries and five predictor variables for *economic performance/governance capacity* (combined phase): GDP = per-capita gross domestic product; IGS = per-capita imports of goods and services; CPI = corruption perception index; VAPP = value-added %GDP from primary production (agriculture, fisheries, and forestry), and STJA = per-capita production of science/technology journal articles. Also shown are the recalculated variance inflation factors for the reduced model (with GDP removed).



Appendix 3: Phase results for response of damage cost:management expenditure (D:M)

Table S2. General linear mixed-effects models of the relationship between the ratio of damage cost to management expenditure among countries and three predictor variables for *economic performance/governance capacity* (Phase 1): IGS = per-capita imports of goods and services; GHSI = global health security index; CPI = corruption perception index. k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
~IGS	4	-94.187	195.533	-	0.440	22.0	41.6
~GHSI+IGS	5	-93.312	196.692	1.159	0.247	21.2	41.7
~CPI+IGS	5	-93.726	197.505	1.972	0.164	21.6	31.4
~CPI+GHSI+IGS	6	-92.615	198.370	2.837	0.107	20.6	42.5
~CPI	4	-96.537	201.314	5.782	0.024	9.6	36.8
~CPI+GHSI	5	-95.495	202.466	6.934	0.014	9.4	40.2
intercept-only	3	-99.754	205.657	10.124	0.003	-	32.2
~GHSI	4	-99.171	207.304	11.771	0.001	0.5	30.1

Fig. S4. Relative contribution of each variable in Phase 1 (*economic performance/governance capacity*) to the variation in the damage cost:management expenditure ratio among countries. IGS = per-capita imports of goods and services; CPI = corruption perception index; GHSI = global health security index.

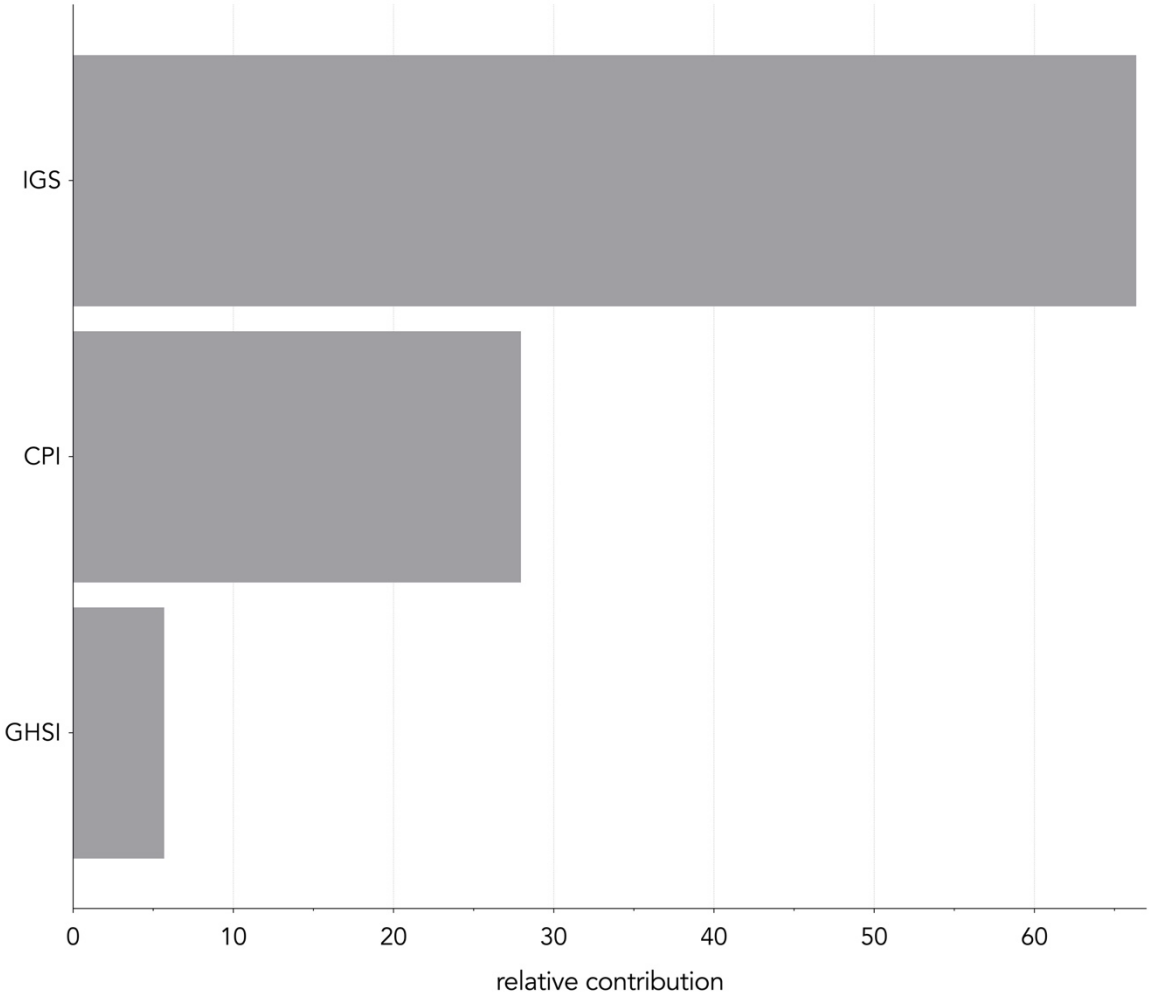


Table S3. General linear mixed-effects models of the relationship between the ratio of damage costs to management expenditure among countries and two predictor variables for *reliance and engagement in primary production* (Phase 2): VAPP = value-added %GDP from primary production (agriculture, fisheries, and forestry); AGRL = proportion of terrestrial land area devoted to agriculture. k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
~AGRL	4	-98.670	204.081	-	0.370	4.6	33.0
~AGRL+VAPP	5	-97.675	204.728	0.647	0.268	7.5	31.8
~VAPP	4	-98.282	205.240	1.159	0.207	5.3	31.0
intercept-only	3	-99.841	205.819	1.738	0.155	-	31.8

Fig. S5. Relative contribution of each variable in Phase 2 (*reliance and engagement in primary production*) to variation in the damage cost:management expenditure ratio among countries. VAPP = value-added %GDP from primary production (agriculture, fisheries, and forestry); AGRL = proportion of terrestrial land area devoted to agriculture.

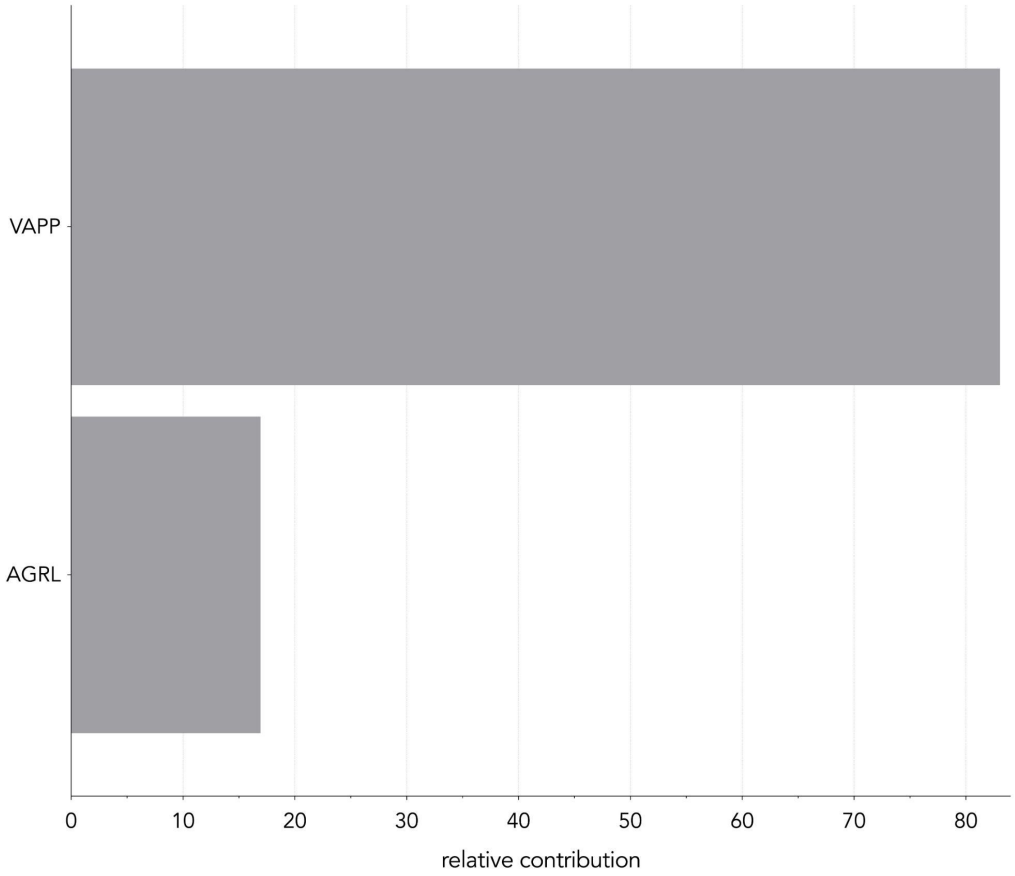


Table S4. General linear mixed-effects models of the relationship between the ratio of damage costs to management expenditure among countries and two predictor variables for *educational and research capability* (Phase 3): STJA = per-capita production of scientific and technical journal articles; EDU = government investment in education (proportion of gross domestic product). k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
~EDU+STJA	5	-97.342	207.203	-	0.358	9.0	26.9
~STJA	4	-100.146	207.780	0.577	0.268	4.4	28.9
intercept-only	3	-100.853	207.856	0.653	0.258	-	31.1
~EDU	4	-99.075	209.473	2.271	0.115	0.6	31.0

Fig. S6. Relative contribution of each variable in Phase 3 (*educational and research capability*) to variation in the damage cost:management expenditure ratio among countries. STJA = per-capita production of scientific and technical journal articles; EDU = government investment in education (proportion of gross domestic product).

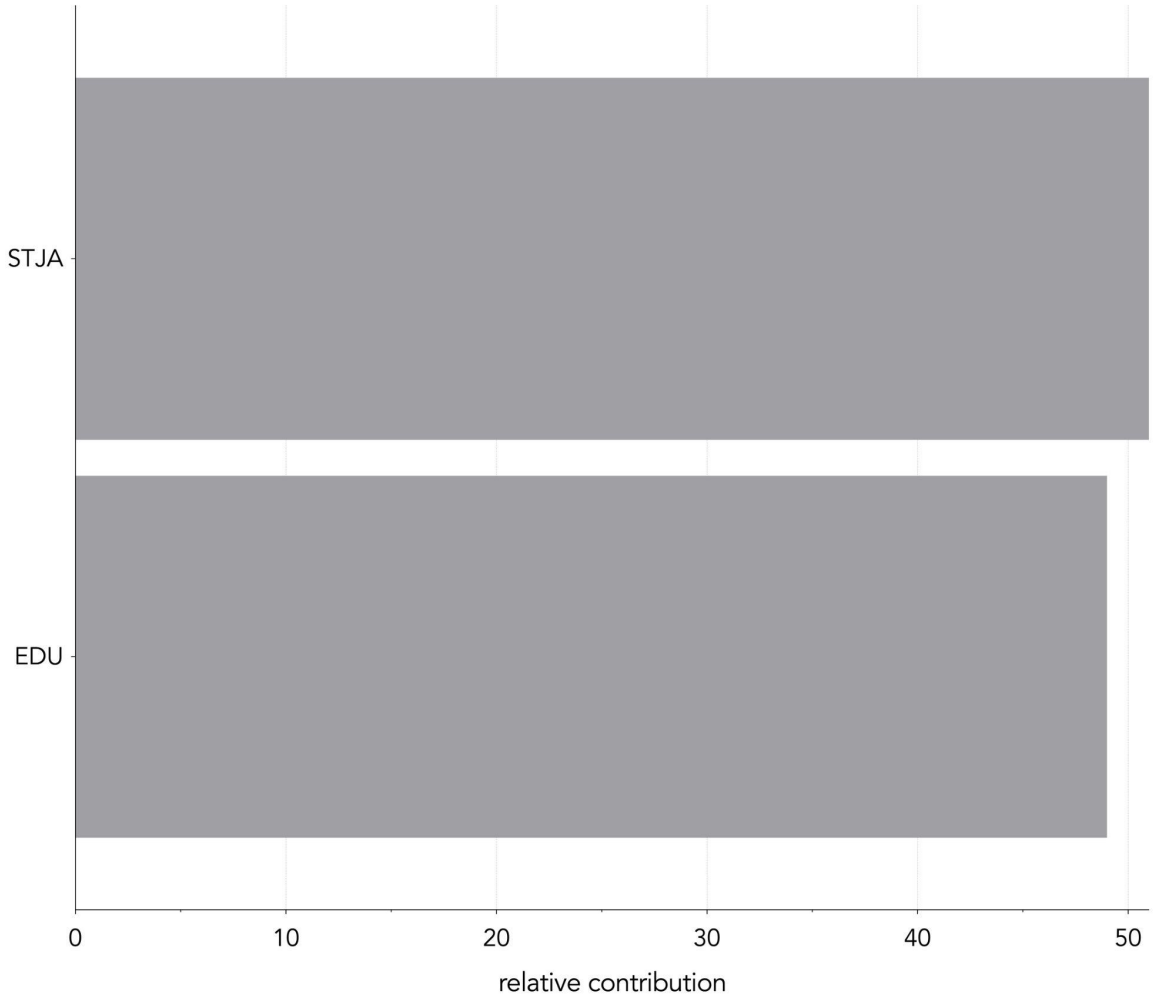


Table S5. General least-squares models with a Gaussian correlation structure of country centroid coordinates of the relationship between the ratio of damage costs to management expenditure among countries and four predictor variables for the combined-phase analysis: IGS = per-capita imports of goods and services; CPI = corruption perception index; VAPP = value-added %GDP from primary production (agriculture, fisheries, and forestry), and STJA = per-capita production of science/technology journal articles. k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); psR^2mcf = pseudo-R^2 (McFadden metric); psR^2cs = pseudo-R^2 (Cox & Snell metric); psR^2cu = pseudo-R^2 (Craig & Uhler metric).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	psR^2mcf	psR^2cs	psR^2cu
~IGS+CPI+VAPP+STJA	8	-93.484	186.969	0	0.217	0.069	0.22	0.227
~IGS +VAPP+STJA	7	-93.488	186.976	0.007	0.216	0.069	0.22	0.226
~IGS+CPI+VAPP	7	-93.492	186.984	0.015	0.215	0.069	0.22	0.226
~IGS+VAPP	6	-93.492	186.984	0.016	0.215	0.069	0.22	0.226
~IGS+CPI+STJA	7	-95.312	190.625	3.656	0.035	0.051	0.168	0.172
~IGS+STJA	6	-95.337	190.675	3.706	0.034	0.051	0.167	0.172
~IGS+CPI	6	-95.5	191	4.031	0.029	0.049	0.162	0.167
~IGS	5	-95.509	191.019	4.05	0.029	0.049	0.162	0.166
~CPI+VAPP+STJA	7	-98.381	196.762	9.793	0.002	0.021	0.071	0.073
~CPI+STJA	6	-98.382	196.763	9.795	0.002	0.021	0.071	0.073
~CPI+VAPP	6	-98.499	196.998	10.03	0.001	0.019	0.067	0.069
~VAPP+STJA	6	-98.693	197.385	10.417	0.001	0.018	0.061	0.063
~CPI	5	-98.533	197.067	10.098	0.001	0.019	0.066	0.068
~VAPP	5	-99.556	199.113	12.144	0.001	0.009	0.031	0.032
~STJA	5	-98.693	197.385	10.417	0.001	0.018	0.061	0.063
intercept-only	4	-100.452	200.904	13.936	-	-	-	-

Appendix 4: Response: proportion of total costs from damage

Given the behaviour of ratios where large shifts can result from variation in either the numerator (damage costs) or denominator (management expenditure), we also considered a modified response where we used the proportion of total costs attributed to damages. In this way, we test whether the relative contribution of damage costs per se varies relative to the socio-economic predictors. For this analysis, we followed the same 3-phase approach as for the ratio of damage costs:management expenditure.

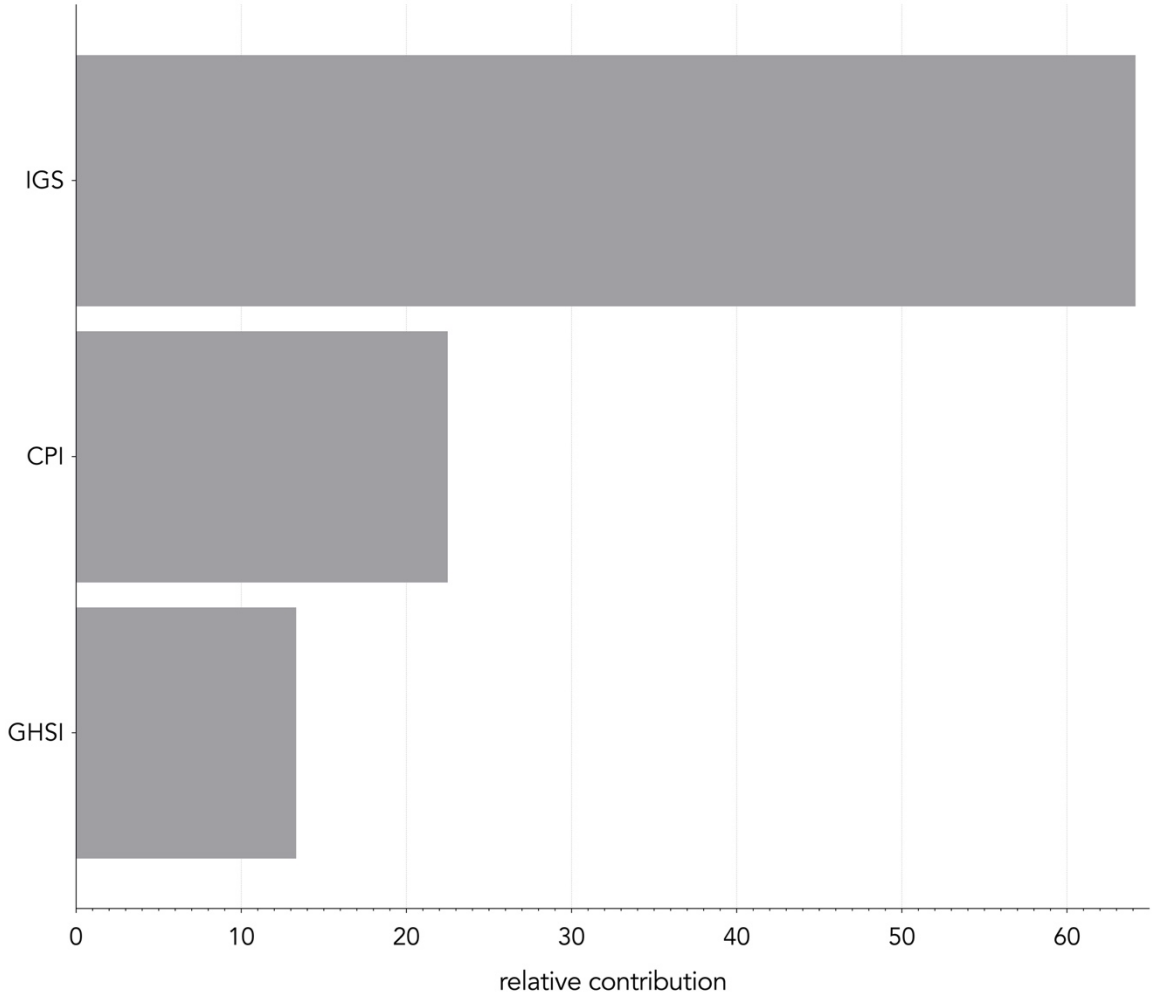
a. Phase 1: economic performance/governance capacity — The general linear mixed-effects models demonstrated approximately equal support for per-capita imports of goods and services in explaining variation in the proportion of total costs attributed to damage among countries (Table S6).

Table S6. General linear mixed-effects models of the relationship between the proportion of total costs due to damage among countries and three predictor variables for *economic performance/governance capacity* (Phase 1): IGS = per-capita imports of goods and services; GHSI = global health security index; CPI = corruption perception index. k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%). GDP was collinear (variance inflation factor = 10.2 [95% confidence interval: 6.7–15.8]).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
~IGS	4	-52.646	109.487	0.000	0.435	13.8	37.9
~CPI+IGS	5	-52.932	111.417	1.930	0.166	13.6	38.0
~GHSI+IGS	5	-52.962	111.485	1.998	0.160	13.7	37.5
~CPI	4	-53.706	112.549	3.062	0.094	6.6	36.6
~CPI+GHSI+IGS	6	-53.159	113.414	3.926	0.061	13.2	37.7
~CPI+GHSI	5	-53.923	114.549	5.061	0.035	6.5	36.3
intercept-only	3	-55.177	114.897	5.410	0.029	0.0	32.7
~GHSI	4	-54.980	115.622	6.135	0.020	2.0	30.4

The boosted regression tree for Phase 1 also supported the inclusion of per-capita imports of goods and services, with a final coefficient of variation = 15.8 ± 11.3% for 12550 trees (Fig. S7).

Fig. S7. Relative contribution of each variable in Phase 1 (*economic performance/governance capacity*) to variation in the proportion of total costs due to damage among countries. IGS = per-capita imports of goods and services; CPI = corruption perception index; GHSI = global health security index.


IGS
CPI
GHSI
0
10
20
30
40
50
60
relative contribution

b. Phase 2: Reliance and engagement in primary production — According to the general linear mixed-effects models, there was sufficient evidence to justify including the proportion of terrestrial land area devoted to agriculture (Table S7).

Table S7. General linear mixed-effects models of the relationship between the ratio of damage to management costs among countries and two predictor variables for *reliance and engagement in primary production* (Phase 2): VAPP = value-added %GDP from primary production (agriculture, fisheries, and forestry); AGRL = proportion of terrestrial land area devoted to agriculture. k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
~AGRL	4	-55.572	114.724	-	0.361	3.7	33.3
intercept-only	3	-55.595	115.750	1.025	0.216	-	32.8
~AGRL+VAPP	5	-55.542	115.770	1.046	0.214	5.6	32.4
~VAPP	4	-55.132	115.827	1.102	0.208	3.9	32.0

The boosted regression tree for Phase 2 did not converge.

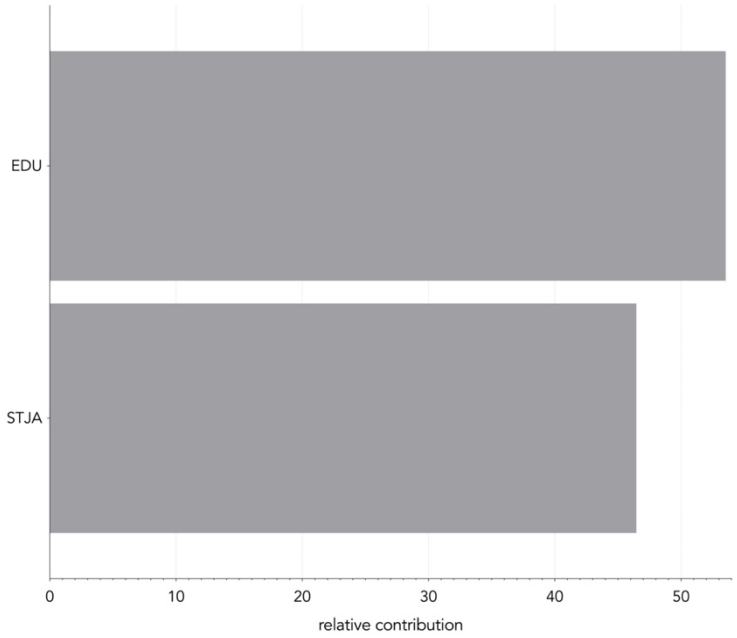
c. Phase 3: Educational and research capability — Although weak, there was some support from the general linear mixed-effects models to include both per-capita production of scientific and technical journal articles and government investment in education in the combined-phase analysis (Table S8). Although the intercept-only model was top-ranked, the model including both predictors had a similar $w\text{AIC}_c$, and there was evidence for an effect of both variables from the boosted regression tree (see below).

Table S8. General linear mixed-effects models of the relationship between variation in the proportion of total costs due to damage among countries and two predictor variables for *educational and research capability* (Phase 3): STJA = per-capita production of scientific and technical journal articles; EDU = government investment in education (proportion of gross domestic product). k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $w\text{AIC}_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$w\text{AIC}_c$	R_m	R_c
intercept-only	3	-55.595	115.750	-	0.363	-	32.8
~EDU+STJA	5	-54.363	116.634	0.884	0.233	5.5	29.3
~STJA	4	-56.120	116.645	0.896	0.232	2.3	31.4
~EDU	4	-54.593	117.256	1.506	0.171	0.7	32.5

The boosted regression tree for Phase 3 also supported the inclusion of per-capita production of scientific and technical journal articles to the proportion of total costs due to damage, with a final coefficient of variation = 26.0 ± 12.1% for 31600 trees (Fig. S8).

Fig. S8. Relative contribution of each variable in Phase 3 (*reliance and engagement in primary production*) to the variation in the proportion of total costs due to damage among countries. STJA = per-capita production of scientific and technical journal articles; EDU = government investment in education (proportion of gross domestic product).



d. Combined-phase analysis — We retained the following four variables for the combined-phase analysis: (*i*) per-capita imports of goods and services, (*ii*) the proportion of terrestrial land area devoted to agriculture, (*iii*) government investment in education, (*iv*) corruption perception index, and (*v*) per-capita production of scientific and technical journal articles. According to the general linear mixed-effects models, the indicators per-capita gross domestic product and government expenditure in education had the highest individual contributions to explaining the variation in the proportion of total costs due to damage among countries (Table S9).

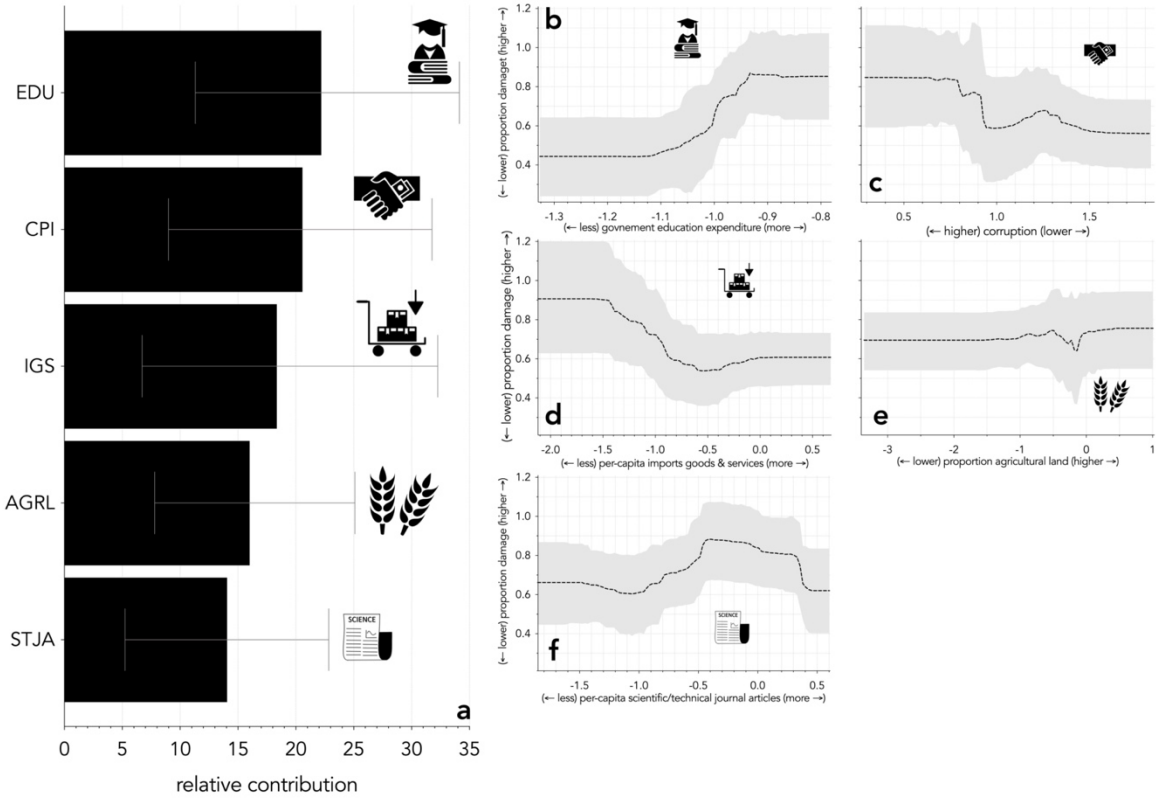
Table S9. General linear mixed-effects models of the relationship between variation in the proportion of total costs due to damage among countries and five predictor variables for the combined-phase analysis: IGS = per-capita imports of goods and services; AGRL = proportion of terrestrial land area devoted to agriculture; STJA = per-capita production of scientific and technical journal articles, CPI = corruption perception index; and EDU = government investment in education (proportion of gross domestic product). k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
~IGS	4	-53.276	110.781	0	0.130	13.0	37.1
~IGS+EDU	5	-52.070	111.659	0.878	0.084	13.6	35.1
~IGS+STJA	5	-53.665	111.969	1.188	0.072	12.1	36.4
~CPI+EDU	5	-51.687	111.968	1.188	0.072	10.5	35.7
~IGS+AGRL	5	-54.427	112.384	1.603	0.058	12.5	36.1
~IGS+CPI+EDU	6	-51.711	112.671	1.890	0.051	13.8	35.9
~IGS+CPI	5	-53.562	112.732	1.951	0.049	12.8	37.1
~IGS+CPI+STJA	6	-53.330	113.125	2.344	0.040	11.2	38.5
~CPI+AGRL+EDU	6	-52.734	113.233	2.453	0.038	11.1	35.3
~IGS+AGRL+EDU	6	-53.255	113.352	2.572	0.036	13.3	34.4
~IGS+STJA+EDU	6	-52.586	113.507	2.727	0.033	12.8	35.0
~IGS+AGRL+STJA	6	-54.863	113.698	2.918	0.030	11.8	35.7
~CPI	4	-54.291	113.752	2.971	0.029	6.1	35.9
~CPI+STJA+EDU	6	-52.142	113.798	3.017	0.029	9.5	38.0
~IGS+CPI+STJA+EDU	7	-51.849	113.941	3.160	0.027	12.4	37.5
~CPI+AGRL	5	-55.003	114.296	3.515	0.022	7.4	35.4
~IGS+CPI+AGRL	6	-54.702	114.328	3.547	0.022	12.3	36.1
~IGS+CPI+AGRL+EDU	7	-52.907	114.388	3.608	0.021	13.4	35.3
~AGRL	4	-55.572	114.724	3.944	0.018	3.7	33.3
~IGS+CPI+AGRL+STJA	7	-54.552	114.904	4.124	0.017	11.1	38.0

~CPI+AGRL+STJA+EDU	7	-53.188	115.058	4.278	0.015	10.2	37.7
~CPI+STJA	5	-54.478	115.092	4.311	0.015	5.5	39.9
~IGS+AGRL+STJA+EDU	7	-53.781	115.242	4.461	0.014	12.6	34.4
~CPI+AGRL+STJA	6	-55.231	115.693	4.912	0.011	6.8	39.4
intercept-only	3	-55.595	115.750	4.969	0.011	-	32.8
~IGS+CPI+AGRL+STJA+EDU	8	-53.083	115.754	4.973	0.011	12.3	37.0
~AGRL+STJA	5	-56.364	116.228	5.447	0.009	4.7	32.4
~AGRL+EDU	5	-54.604	116.264	5.483	0.008	4.3	33.1
~STJA+EDU	5	-54.363	116.634	5.854	0.007	5.5	29.3
~STJA	4	-56.120	116.645	5.865	0.007	2.3	31.4
~AGRL+STJA+EDU	6	-54.852	116.742	5.962	0.007	7.3	30.4
~EDU	4	-54.593	117.256	6.475	0.005	0.7	32.5

The full- and resampled-dataset boosted regression tree analyses for the combined phases supported the effects of per-capita gross domestic product and government expenditure in education (and some modest support for a small rise in proportional damage costs with increasing proportions of agricultural land), with a final coefficient of variation = 30.0 ± 17.9% for 19300 trees in the full-dataset analysis, and 44.4–78.4% for the resampled-dataset analysis (Fig. S9). Here, the proportional costs arising from damages increase as countries invest more in education, and decrease as trade volume and corruption increase.

Fig. S9. (**a**) Relative contribution and relationships in predictor variables (**b**–**f**) to variation in the proportion of total costs due to damage derived from boosted regression trees, explaining 44.4–78.4% of the deviance. (**a**) Bars represent the relative influence of the resampled-dataset boosted regression trees (± 95% confidence bounds) for the variables described below. Predicted proportion of total costs due to damage expressed as a function of variation in (**b**) EDU = government investment in education (proportion of gross domestic product), (**c**) IGS = per-capita import of goods and services, (**d**) CPI = corruption perception index, (**e**) AGRL = proportion land area used for agriculture, and (**f**) STJA = per-capita production of science and technical journal articles.


EDU
CPI
IGS
AGRL
STJA
SCIENCE
a
0
5
10
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25
30
35
relative contribution
b
(← lower) proportion damaget (higher →)
1.2
1.0
0.8
0.6
0.4
-1.3
-1.2
-1.1
-1.0
-0.9
-0.8
(← less) govnement education expenditure (more →)
c
0.5
1.0
1.5
(← higher) corruption (lower →)
d
(← lower) proportion damage (higher →)
-2.0
-1.5
-1.0
-0.5
0.0
0.5
(← less) per-capita imports goods & services (more →)
e
-3
-2
-1
0
1
(← lower) proportion agricultural land (higher →)
f
(← lower) proportion damage (higher →)
-1.5
-1.0
-0.5
0.0
0.5
(← less) per-capita scientific/technical journal articles (more →)

Appendix 5: Response: median instantaneous exponential rate of temporal change (*r*) in damage costs:management expenditure ratio

We also considered a modified response where we used the median rate of instantaneous exponential rate of change in the ratio of damage cost:management expenditure over time to test the hypothesis that increasing capacity leads to a reduction in the ratio over time (i.e., damage costs decline at a faster rate than management expenditure increases).

a. Phase 1: economic performance/governance capacity — The general linear mixed-effects models demonstrated little support for any of the variables considered (Table S10).

Table S10. General linear mixed-effects models of the relationship between the median instantaneous exponential rate of temporal change in the ratio of damage cost:management expenditure among countries and four predictor variables for *economic performance/governance capacity* (Phase 1): IGS = per-capita imports of goods and services; GDP = per-capita gross domestic product; GHSI = global health security index; CPI = corruption perception index. k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
intercept-only	3	7.2	-13.290	0.000	0.260	–	6.1
~GHSI	4	5.819	-11.636	1.653	0.114	0.5	5.8
~CPI	4	5.487	-11.583	1.707	0.111	0.3	5.1
~GDP	4	5.235	-11.406	1.883	0.101	<0.1	6.7
~IGS	4	5.039	-11.367	1.923	0.099	<0.1	6.8
~CPI+GHSI	5	4.288	-9.709	3.580	0.043	0.5	5.6
~GDP+GHSI	5	4.174	-9.638	3.651	0.042	0.5	7.0
~GHSI+IGS	5	3.849	-9.636	3.653	0.042	0.5	7.1
~GDP+CPI	5	4.074	-9.589	3.701	0.041	0.2	6.5
~CPI+IGS	5	3.754	-9.589	3.701	0.041	0.3	6.3
~GDP+IGS	5	4.07	-9.411	3.879	0.037	0.1	7.3
~GDP+CPI+GHSI	6	3.011	-7.776	5.513	0.016	0.6	6.8
~CPI+GHSI+IGS	6	2.594	-7.733	5.556	0.016	0.5	6.8
~GDP+GHSI+IGS	6	3.054	-7.647	5.642	0.015	0.5	7.1
~GDP+CPI+IGS	6	2.914	-7.589	5.700	0.015	0.2	7.0
~GDP+CPI+GHSI+IGS	7	1.901	-5.790	7.500	0.006	0.6	6.9

The boosted regression tree for Phase 1 did not converge, so we did not include any economic performance/governance capacity variables in the final-phase model (see below).

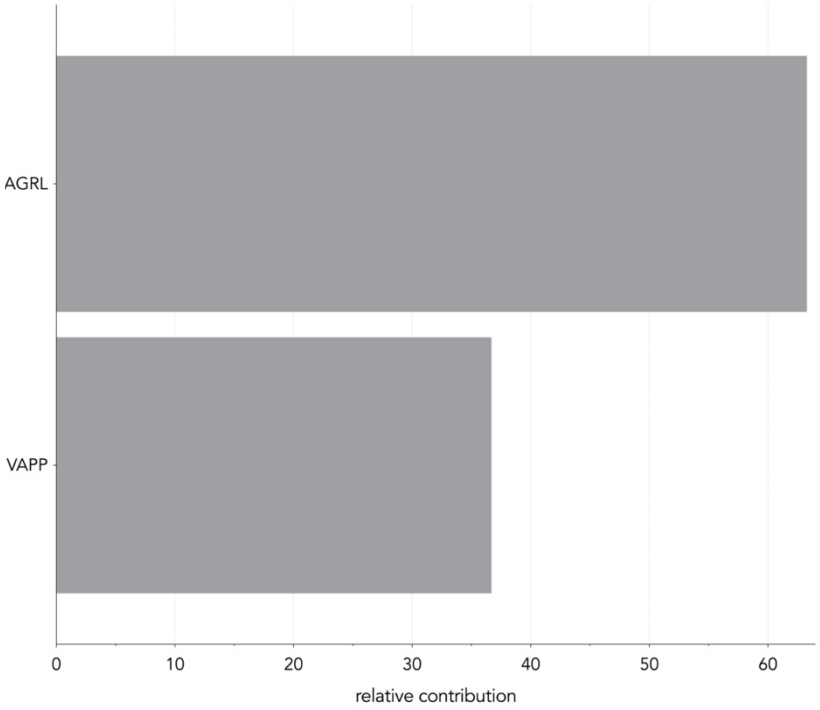
b. Phase 2: Reliance and engagement in primary production — According to the general linear mixed-effects models, there was sufficient evidence to justify including the proportion of terrestrial land area devoted to agriculture (Table S11).

Table S11. General linear mixed-effects models of the relationship between the median instantaneous exponential rate of temporal change in the ratio of damage cost:management expenditureamong countries and two predictor variables for *reliance and engagement in primary production* (Phase 2): VAPP = value-added %GDP from primary production (agriculture, fisheries, and forestry); AGRL = proportion of terrestrial land area devoted to agriculture. k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
~AGRL+VAPP	5	9.220	-22.941	0	0.485	16.2	17.7
~AGRL	4	10.220	-22.901	0.040	0.475	13.1	17.1
intercept-only	3	9.064	-17.207	5.735	0.028	0	4.5
~VAPP	4	7.451	-15.635	7.306	0.013	0.4	4.6

The boosted regression tree for Phase 2 also showed most support for the proportion of land area devoted to agriculture, with a coefficient of variation = 12.1 ± 19.7% for 82700 trees (Fig. S10).

Fig. S10. Relative contribution of each variable in Phase 1 (*economic performance/governance capacity*) to variation in the median instantaneous exponential rate of temporal change in the ratio of damage cost:management expenditure among countries. VAPP = value-added %GDP from primary production (agriculture, fisheries, and forestry); AGRL = proportion of terrestrial land area devoted to agriculture.



c. Phase 3: Educational and research capability — There was little support for either of the two variables in the general linear mixed-effects models (Table S12).

Table S12. General linear mixed-effects models of the relationship between the median instantaneous exponential rate of temporal change in the ratio of damage cost:management expenditure among countries and two predictor variables for *educational and research capability* (Phase 3): STJA = per-capita production of scientific and technical journal articles; EDU = government investment in education (proportion of gross domestic product). k = number of model parameters; ℓ = log-likelihood; AIC_c = Akaike's information criterion corrected for small samples; ΔAIC_c = difference between model and top-ranked model; $wAIC_c$ = AIC_c weight (≈ model probability); R_m = marginal R^2; R_c = conditional R^2 (%).

model	k	ℓ	AIC_c	ΔAIC_c	$wAIC_c$	R_m	R_c
intercept-only	3	9.064	-17.207	-	0.508	-	4.5
~STJA	4	6.805	-15.476	1.730	0.214	0.1	4.9
~EDU	4	8.682	-15.321	1.886	0.198	0.1	4.4
~EDU+STJA	5	6.586	-13.495	3.711	0.079	0.1	4.9

The boosted regression tree for Phase 3 did not converge.

References

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