APPENDIX 1

Table A 1.1. Coding Criteria

PIs/ Authors' Discipline	Examples of Specific Department or Employer
1) Biological/Life Science	Agriculture, Biology, Botany, Conservation, Ecology, Environmental, Forestry, Forestry Service, Life Science, Limnology, Ornithology, Medicine, Natural Resources, Trout Station, Zoology
2) Social Science	Anthropology, Archaeology, Economics, Education, Law, Political Science, Public Policy, Social Science, Sociology
3) Physical Science	Astronomy, Chemistry, Energy, Geology, Hydrology, Meteorology, Oceanography, Physics, Soil & Water Science
4) Computer Science/ Math/Engineering	Architecture, Civil Engineering, Environmental Engineering, Civil & Environmental Engineering, Mechanical and Aerospace Engineering, Software engineering, Electrical and Computer Engineering, Computer Science, Information Science, Mathematics
5) Interdisciplinary	Business, “Development” departments, Geography, Finance, “Planning” departments, Resilience, Sustainability. Any department title that combines two disciplines from separate categories: (eg. Environmental Economics; Food, Agriculture & Development; Civil and Environmental Engineering & Earth Sciences; Biological and Ecological Engineering). Any Museums or Centers that may include members from natural sciences, social sciences, and humanities. Any individual who is affiliated with more than one academic department from different discipline categories.
6) Undefined	"Consulting" or people who are unaffiliated

Analysis Method	Criteria
1) Conceptual/Literature Review	Conceptual models, literature reviews, or case studies. These articles may descriptively explain relationships among different factors/concepts, review the literature on a specific concept or topic, or descriptively explain an individual/particular case study without using a quantitative analysis.
2) Statistics	Inferential analysis showing relationships among factors, such as Regression, ANOVA, Bayesian models, Meta-analysis, and Markov Chain Monte Carlo (MCMC).
3) Spatial Analysis	GIS with layers of maps. It may use statistical analysis to analyze results across spatial differences.
4) Mathematical Analysis	Mathematical formulas to explain conceptual relations, such as economic analysis or cost-benefit calculations.
5) Simulation Model Analysis	Explicitly simulate a study system including agent-based models, system dynamics models, temporal and spatial dynamics models, or interactive data language models.
6) Other	Meeting summary or observation report.

Degree of Coupling	**Coding**	**Criteria**
Incomplete Linkages	1.No linkages	If both one-way linkages are "No", the research presents no linkages.
	2. One-way linkages from natural to human systems	If any components from a natural system cause a change(s) of a component(s) in a human system, we code as "Yes". Otherwise, "No"
	2. One-way linkages from human to natural systems	If any components from a human system cause a change(s) of a component(s) in a natural system, we code as "Yes". Otherwise, "No"
Two-Way Linkages	3.Two-way linkages	If both one-way linkages are "Yes", the research presents a two-way linkage

Table A 1.2 Intercoder reliability by coding category

Subject	No. of testing sample	No. of criteria to match	% Agreement	Cohen's Kappa
Authors' Discipline	220 authors (from 36 articles)	6	82%	0.724
Analysis Method	36 articles	5	97%	0.958
No Linkages	36 articles	2	100%	1
One-Way Linkages Natural-->Human	36 articles	2	94%	0.769
One-Way Linkages Human-->Natural	36 articles	2	100%	1
Two-Way Linkages	36 articles	2	94%	0.769

Supplemental Analysis:

As an additional exercise, we also conducted the same chi-square and ANOSIM tests examining how each team or article attribute related to degree of coupling when all three linkage types were examined. Again, PIs specific disciplines were not associated with degree of coupling ($\chi 2 = 5.26$, df = 8, $p = 0.73$), and no significant difference between sampled chi-squares and the chi-square of the observed data ($p = 0.74$). The diversity of PI's academic disciplines did not significantly differ for articles with two-way linkages (*H*' = 1.21), one-way linkages (*H*' = 0.65), or no linkages (*H*' = 1.04), ANOSIM R = 0.00, $p = 0.44$.

However, we did find a significant association between authors' specific discipline and the degree of coupling ($\chi^2 = 57.16$, $df = 8$, $p < .001$) as well as a significant difference between the sampled chi-squares and the chi-square of the observed data ($p < .001$, see Table A 1.3). The significant associations come from all disciplines except authors from computer science/math/engineering. Physical science authors were more likely to be involved in no-linkage articles (Residuals = 4.30, $p < .001$) and less likely to be involved in two-way linkage articles (Residuals = -3.61, $p = .005$). Biological/life authors were less likely to be involved in two-way linkage articles (Residuals = -3.37, $p = .01$). In contrast, interdisciplinary authors were less likely to be involved in no-linkage articles (Residuals = -4.18, $p < .001$) and more likely to be involved in two-way linkage articles (Residuals = 4.68, $p < .001$). Social science authors were less likely to be involved in no-way linkage articles with a marginal extent (Residuals= -2.77, $p = .08$). Authors from computer science/math/engineering did not lead to significant differences in degree of coupling ($p = .86$). The diversity of authors' academic disciplines did not significantly differ for articles with two-way linkages (*H*' = 1.38), one-way linkages (*H*' = 1.19), or no linkages (*H*' =1.24), ANOSIM R = 0.04, $p = .24$.

Table A 1.3. Observed values and expected values demonstrating the relationship between authors' disciplines and degree of coupling in the articles

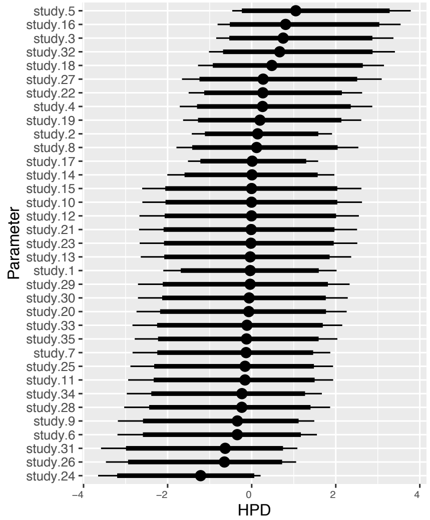
	Biological/Life		Social Science		Physical Science		Computer Science/ Math/ Engineering		Interdisciplinary		Total
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	
No Linkages	382 (27.3%)	365.5 (26.1%)	42 (3.0%)	55.3 (4.0%)	102 (7.3%)	77.8 (5.6%)	57 (4.1%)	49.3 (3.5%)	183 (13.1%)	218.1 (15.6%)	766 (54.8%)
One-Way Linkages	206 (14.7%)	199.9 (14.3%)	35 (2.5%)	30.3 (2.2%)	33 (2.4%)	42.6 (3.0%)	19 (1.4%)	27.0 (1.9%)	126 (9.0%)	119.3 (8.5%)	419 (30.0%)
Two-Way Linkages	79 (5.7%)	101.6 (7.3%)	24 (1.7%)	15.4 (1.1%)	7 (0.5%)	21.6 (1.5%)	14 (1.0%)	13.7 (1.0%)	89 (6.4%)	60.6 (4.3%)	213 (15.2%)
Total	667 (47.7%)		101 (7.2%)		134 (10.2%)		90 (6.4%)		398 (28.5%)		1398 (100%)

We also found a significant association between analysis method and the degree of coupling ($\chi^2 = 35.46$, $df = 10$, $p < .001$) as well as a significant difference between the sampled chi-squares and the chi-square of the observed data ($p < .001$, see Table A 1.4). Articles that used statistics were less likely to include two-way linkages (Residuals = -3.73, $p = .002$) and more likely to include no linkage (Residuals = 2.88, $p = .07$). Alternately, conceptual/literature review articles were more likely to include two-way linkages (Residuals = 3.77, p =.003). The other analysis methods (spatial analysis, mathematical analysis, and simulation model analysis, and "other") did not lead to significant differences in degree of coupling $p > .30$.

Table A 1.4. Observed values and expected values demonstrating the relationship between analysis method and detailed degree of coupling in the articles

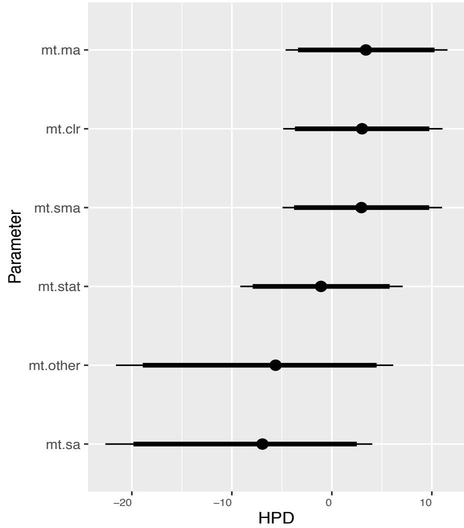
	Conceptual/ Literature review		Statistics		Spatial analysis		Mathematical analysis		Simulation model analysis		Others		Total
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp	Obs.	Exp.	Obs.	Exp.	
No linkage	26 (10.8%)	26.7 (11.1%)	51 (21.2%)	40.3 (16.7%)	8 (3.3%)	10.3 (4.3%)	4 (1.7%)	5.2 (2.1%)	23 (9.5%)	30.0 (12.5%)	1 (0.2%)	0.47 (0.2%)	113 (46.9%)
One-way	15 (6.2%)	22.7 (9.4%)	33 (13.7%)	34.3 (14.2%)	14 (5.8%)	8.8 (3.6%)	4 (1.7%)	4.4 (1.8%)	30 (12.4%)	25.5 (10.6%)	0 (0 %)	0.40 (0.2%)	96 (39.8%)
Two-way	16 (6.6%)	7.6 (3.1%)	2 (0.8%)	11.5 (4.7%)	0 (0%)	2.9 (1.2%)	3 (1.2%)	1.5 (0.6%)	11 (4.6%)	8.5 (3.5%)	0 (0%)	0.13 (0.1%)	32 (13.3%)
Total	57 (23.7%)		86 (35.8%)		22 (9.1%)		11 (4.6%)		64 (26.6%)		1 (0.4%)		241 (100%)

Figure A 1.1. Posterior distributions of odds ratios of each grant award's likelihood of producing articles that include two-way linkages



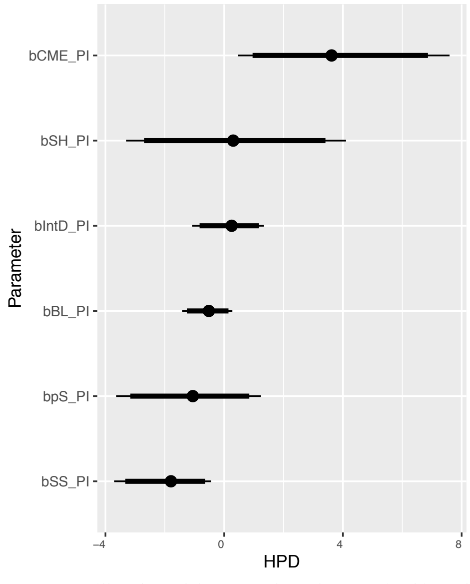
Note: Caterpillar plots of the output from the Bayesian hierarchical logistic regression analysis (including 90% Bayesian credible intervals). The figure displays the random effects of each grant on its likelihood of producing articles that include two-way linkages. The y-axis indicates grant numbers and the x-axis indicates highest posterior density (HPD) interval for each grant award.

Figure A 1.2. Posterior distributions of odds ratios of analysis method and likelihood of articles including two-way linkages



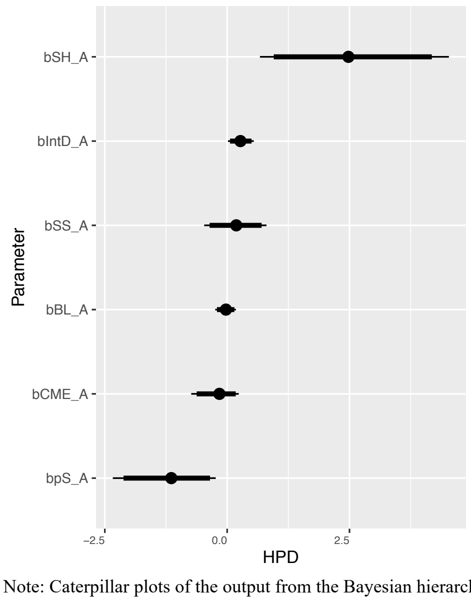
Note: Caterpillar plots of the output from the Bayesian hierarchical logistic regression analysis (including 90% Bayesian credible intervals). The figure displays the effects of each analysis method on likelihood of two-way linkages. The y-axis indicates analysis method categories: mt.ma = mathematic analysis, mt.clr = conceptual/literarture review, mt.sma = simulation model analysis, mt.stat = statisical analysis, mt.other = other, mt.sa=spatial analysis. The x-axis indicates highest posterior density (HPD) interval for each analysis method category.

Figure A 1.3. Posterior distributions of odds ratios of PIs' disciplines and likelihood of articles including two-way linkages



Note: Caterpillar plots of the output from the Bayesian hierarchical logistic regression analysis (including 90% Bayesian credible intervals). The figure displays the effects of each PI academic discipline and diversity of PI's disciplines on likelihood of two-way linkages. The y-axis indicates PI's disciplines: bCME_PI = computer science/math/engineering, bSH_PI = Shannon diversity index for PIs, bIntD_PI = interdisciplinary, bBL_PI = biological/life science , bpS_PI = physical science, bSS_PI = social science. The x-axis indicates highest posterior density (HPD) interval for each PI factor.

Figure A 1.4. Posterior distributions of odds ratios of authors' disciplines and likelihood of articles including two-way linkages



Note: Caterpillar plots of the output from the Bayesian hierarchical logistic regression analysis (including 90% Bayesian credible intervals). The figure displays the effects of each author academic discipline and diversity of authors' disciplines on likelihood of two-way linkages. The y-axis indicates authors' disciplines: bCME_A = computer science/math/engineering, bSH_A = Shannon diversity index for authors, bIntD_A = interdisciplinary, bBL_A = biological/life science, bpS_A = physical science, bSS_author = social science. The x-axis indicates highest posterior density (HPD) interval for each author factor.