Supplementary information

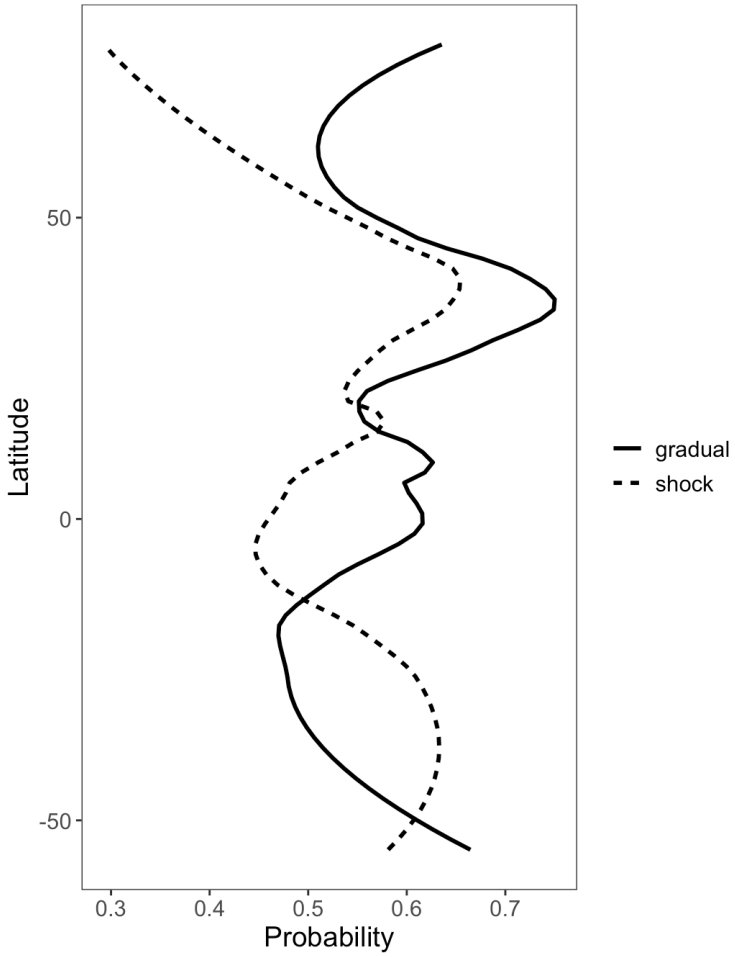
Supplementary Table 1, Supplementary Figures 1–12, Supplementary References 1–4

Supplementary Table

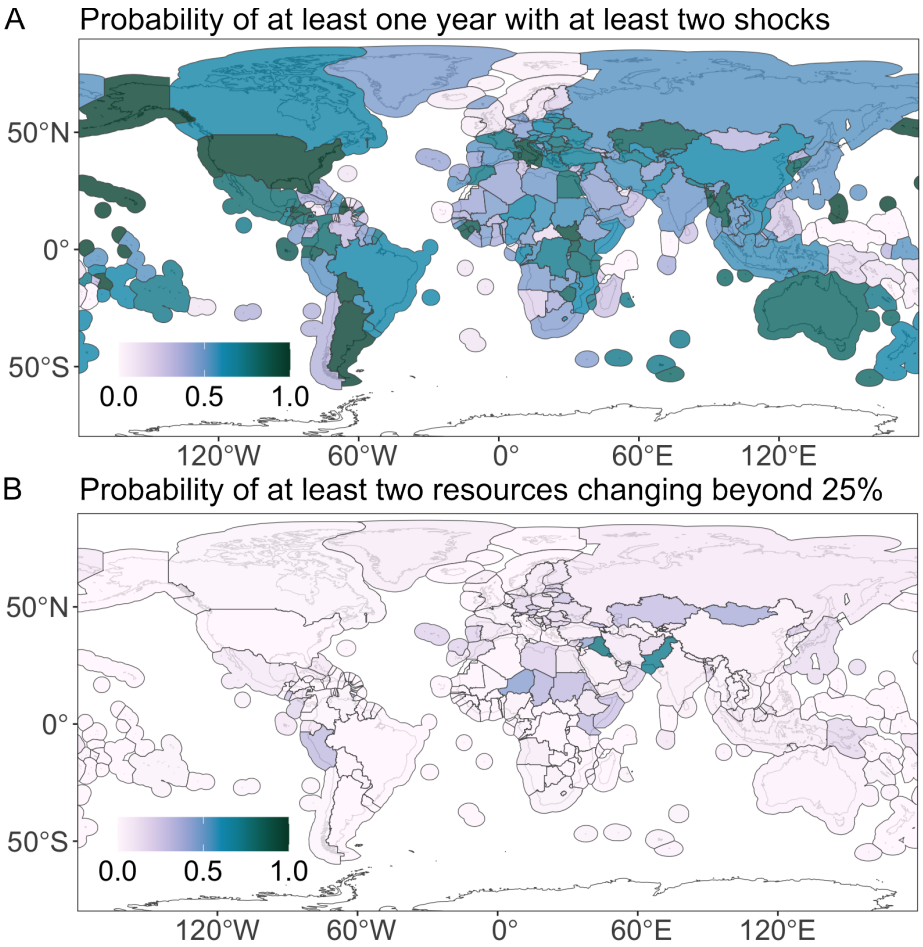
Supplementary Table 1: List of Inter-Sectoral Impact Model Intercomparison Project (ISIMIP3b) simulations selected for data processing. "#" denotes when only one climate model was available for the model simulations. More about specificities on the ISIMIP protocol can be found online (https://www.isimip.org/protocol/3/).

Sector	Output variables	Unit	Climate models	Climate scenarios	Resource models	Resolutions
Agriculture[1]	Wheat crop yield `whe`	[$t.ha^{-1}$]	GFDL-ESM4 IPSL-CM6A-LR	ssp126_2015soc ssp585_2015soc	CROVER CYGMA1p74 DSSAT-Pythia EPIC-IIASA ISAM LDNDC LPJ-GUESS LPJmL pDSSAT PEPIC PROMET SIMPLACE-LINTUL5	annual 0.5° grid
	Maize crop yield `mai`	[$t.ha^{-1}$]	GFDL-ESM4 IPSL-CM6A-LR	ssp126_2015soc ssp585_2015soc		annual 0.5° grid
	Soy crop yield `soy`	[$t.ha^{-1}$]	GFDL-ESM4 IPSL-CM6A-LR	ssp126_2015soc ssp585_2015soc		annual 0.5° grid
	Rice crop yield `ric`	[$t.ha^{-1}$]	GFDL-ESM4 IPSL-CM6A-LR	ssp126_2015soc ssp585_2015soc		annual 0.5° grid
Fisheries and marine ecosystems (global)[2]	Total consumer biomass in log10 weight bins `tcblog10` with weight bins 2 to 6 selected	[$kg.m^{-2}$]	GFDL-ESM4 IPSL-CM6A-LR	ssp126_nat ssp585_nat	APECOSM[#] BOATS DBPM[#] EcoTroph MACROECOLOGICAL ZooMSS	annual or monthly 0.5° grid
Water (global)[3]	Total freshwater surface runoff `qtot`	[$kg.m^{-2}.s^{-1}$]	GFDL-ESM4 IPSL-CM6A-LR	ssp126_2015soc ssp585_2015soc	H08 JULES-W2 MIROC-INTEG-LAND VISIT WaterGAP2-2e	monthly 0.5° grid

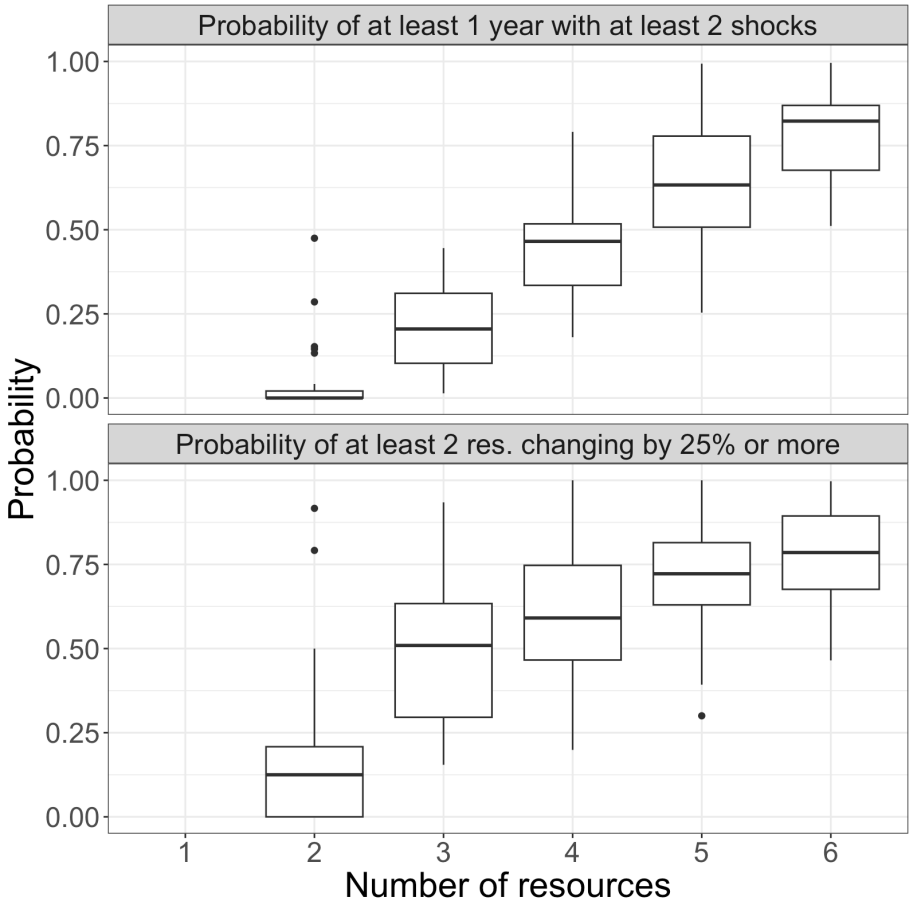
Supplementary Figures



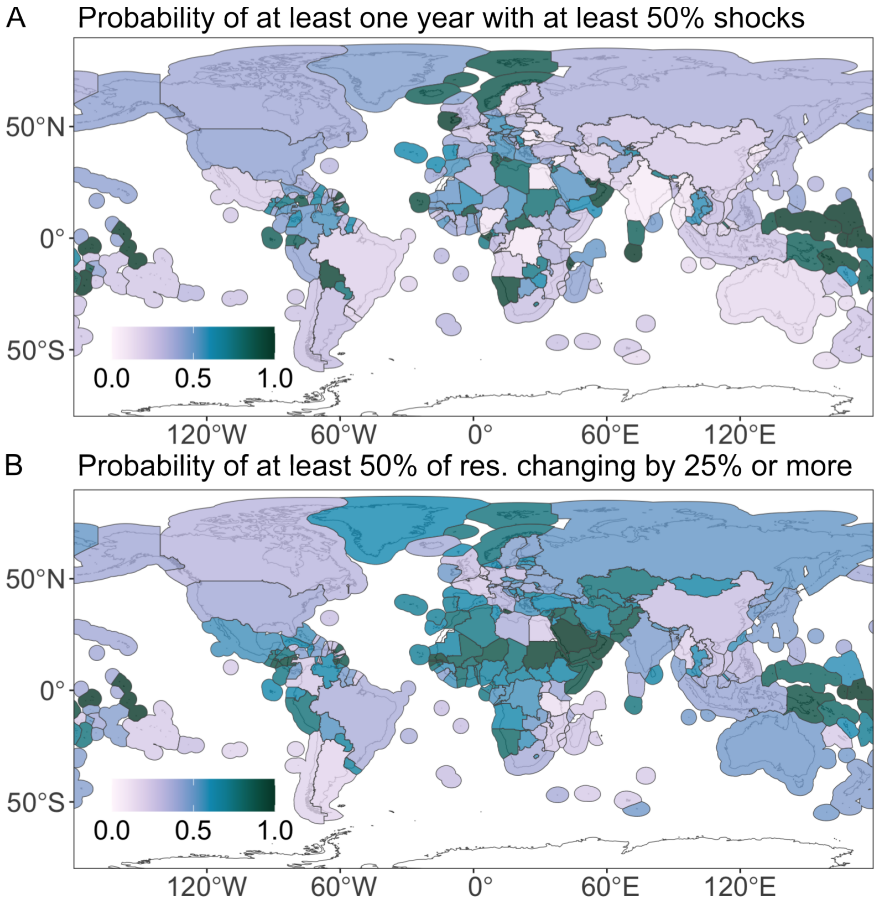
Supplementary Figure 1: Latitudinal gradients by exposure type corresponding to the maps on Figure 1A,B. The gradients were generated by fitting a loess smoother with a span of 0.35 on the indicator values along the latitudinal axis. Each polygon on the world maps was associated with its centroid latitude value.



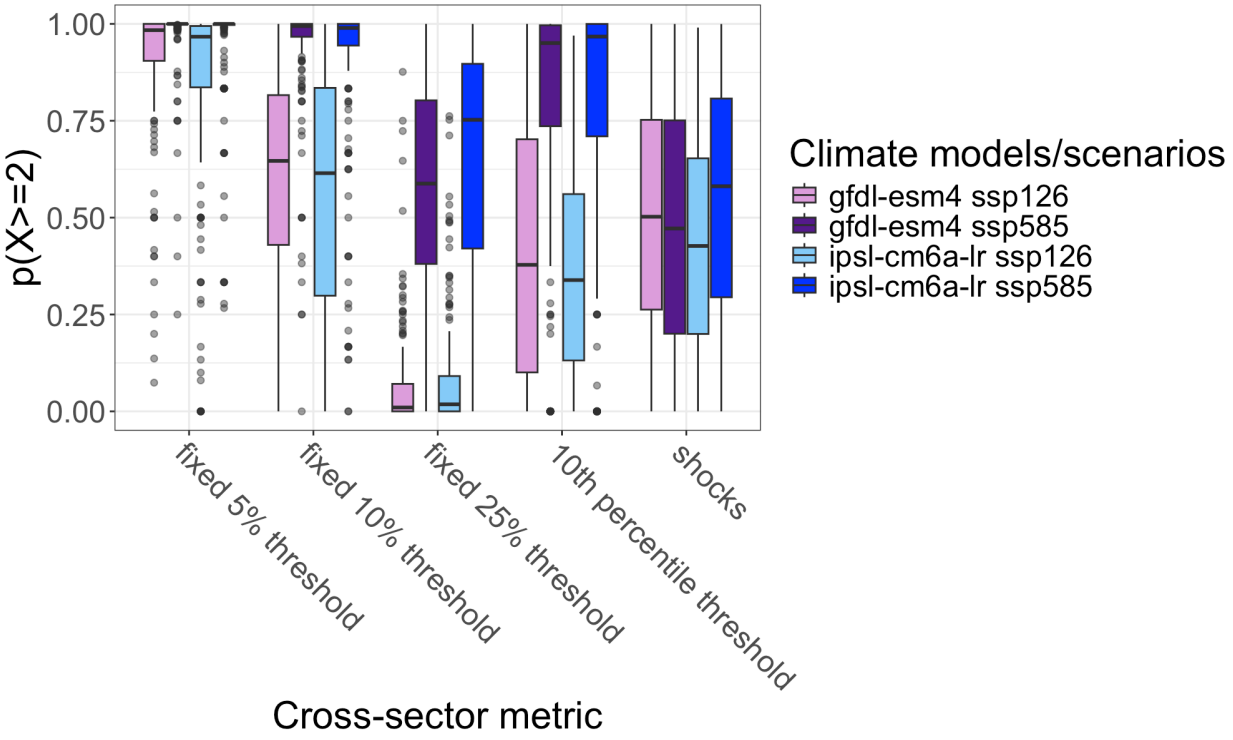
Supplementary Figure 2: Spatial distribution of cross-sector shocks and gradual change metrics under SSP 1-2.6. Cross-sector change was measured with: (A) the probability of at least one year with at least two shocks towards the end of the century (2070-2100), or (B) the probability of at least two resources changing by 25% or more towards the end of the century. Maps display metrics under the low greenhouse gas emissions climate scenario SSP 1-2.6. The geographic delineation merges national land and exclusive economic zones[4].



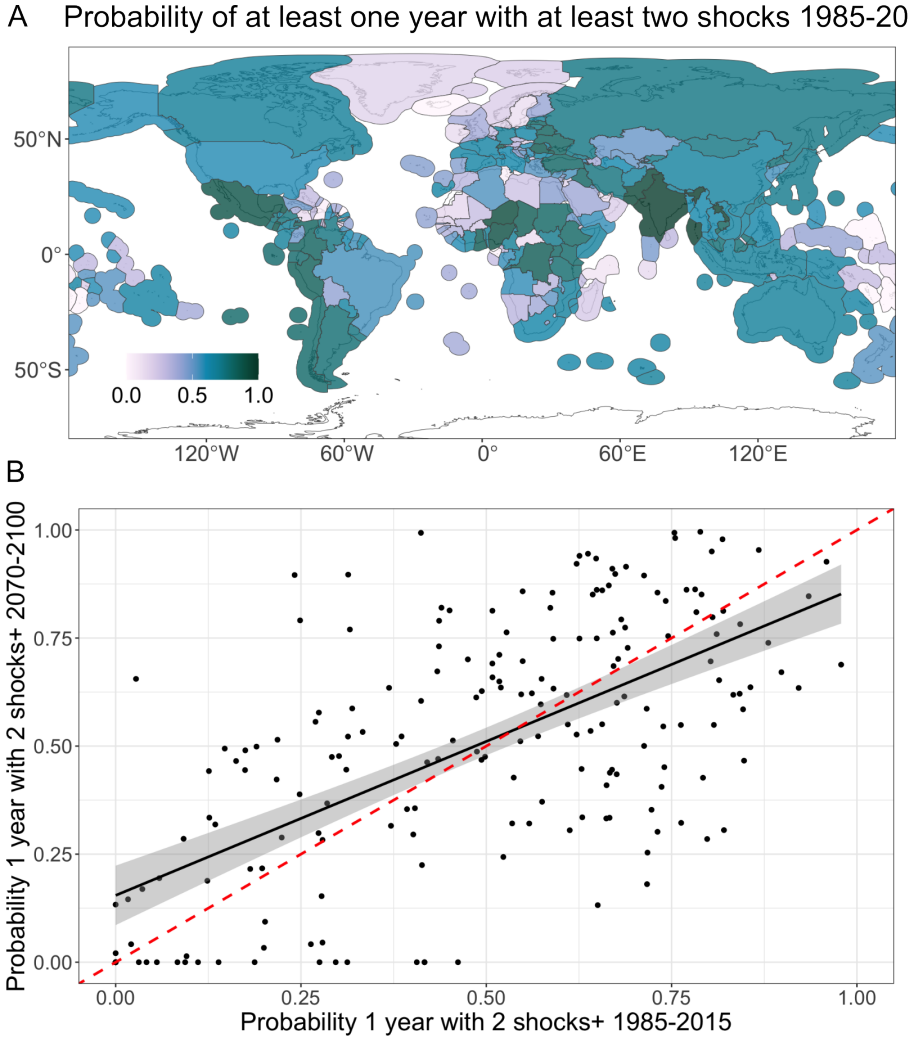
Supplementary Figure 3: Relationship between the probability that at least two resources change and the number of resources per country across the cross-sector change metrics. Calculation of the probability metric is described by (eq. 2) in the Methods.



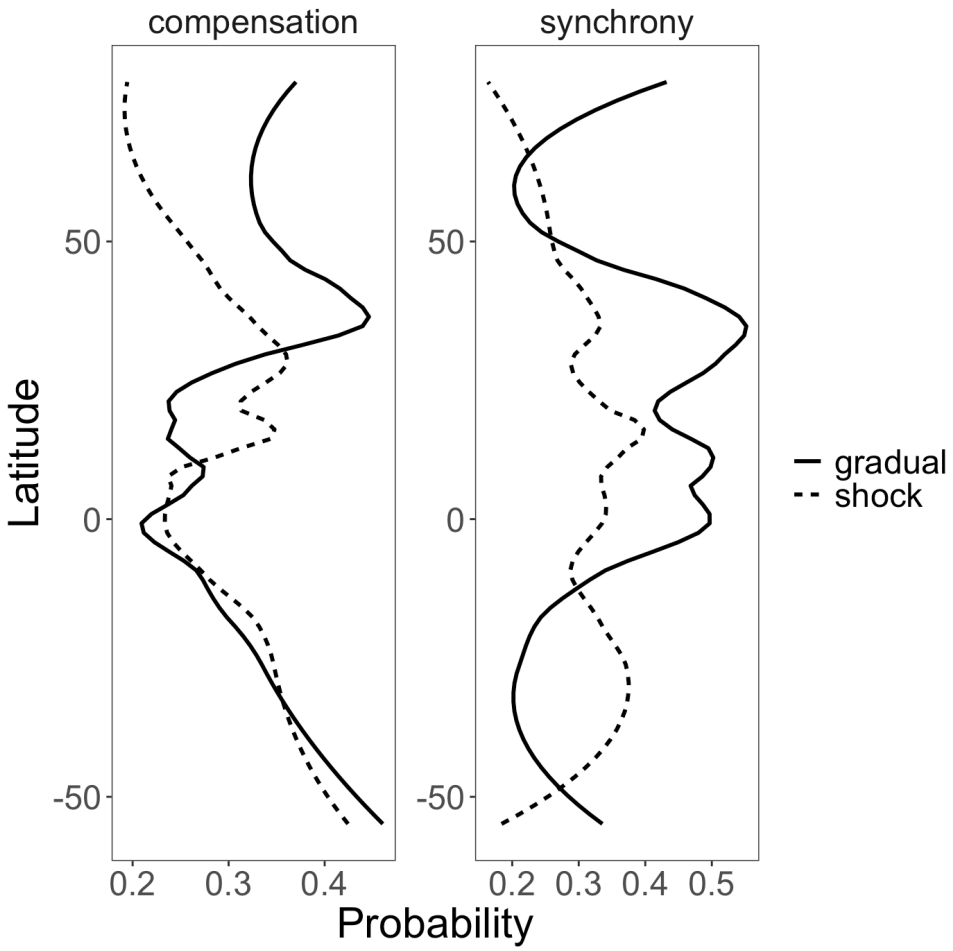
Supplementary Figure 4: Global patterns of the probability that at least 50% of resources change across sectors. The probability that at least 50% of resources change was calculated for (A) shocks, as the probability of at least one year during which at least 50% of resources experience a shock and gradual changes (B) gradual changes, as the probability that are least 50% of resources change by 25% or more by the end of the century. Each map shows the average probability across climate models for SSP 5-8.5. Calculation of the probability metric is described by (eq. 3) in the Methods.



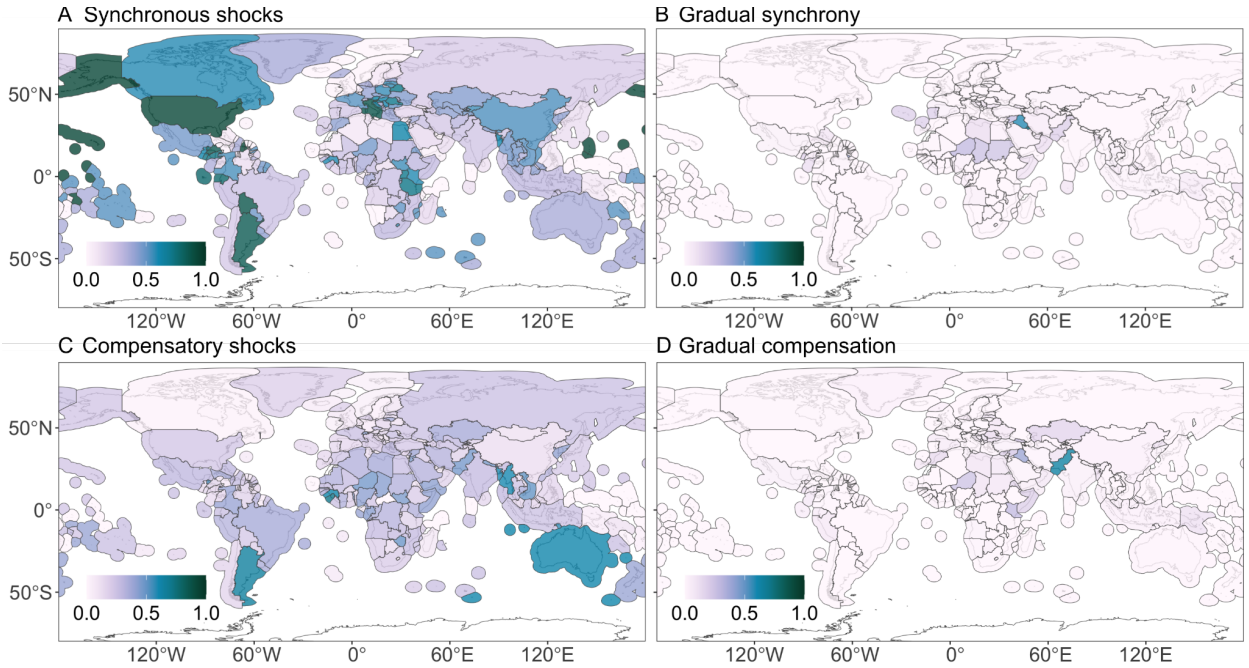
Supplementary Figure 5: Comparison of alternative cross-sector metrics. The gradual resource change metric was calculated with the probability of at least two resources changing by a fixed threshold of 5, 10, or 25% or more by the end of the century. The resource change based on a historical threshold was calculated with the probability of at least two resources changing by the 10th percentile threshold from the historical period or more. The shocks were calculated with the probability of at least one year with at least two shocks by the end of the century. Differences between the metrics tested are described in the section “Resource change metrics” in the Methods. Calculations of the probability metrics are described in the section “Cross-sector change” of the Methods. The two climate models and two climate scenarios are indicated by colors. Each boxplot represents the distribution of probability values across countries of the world.



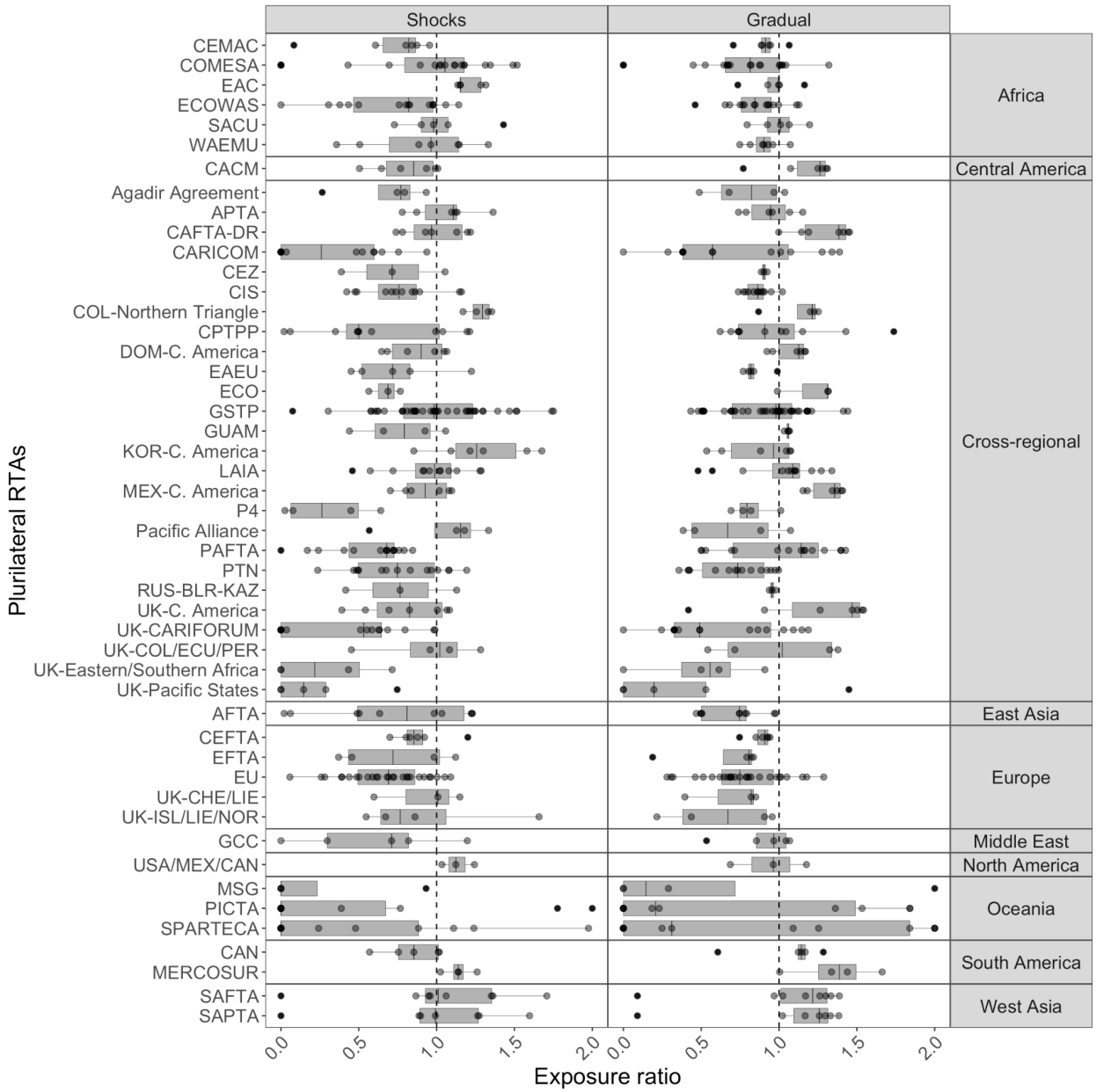
Supplementary Figure 6: Historical shock probabilities. (A) Global probability of at least one year with at least two shocks across the historical reference period 1985-2015. (B) Relationship between the cross-sector shocks probability across 2070-2100 under the SSP 5-8.5 climate scenario included in the main analysis and the cross-sector shocks probability across the reference period 1985-2015. The linear relationship is displayed by the black line. The 1-to-1 line is indicated with the red dashed line. Each dot on the graph is a country.



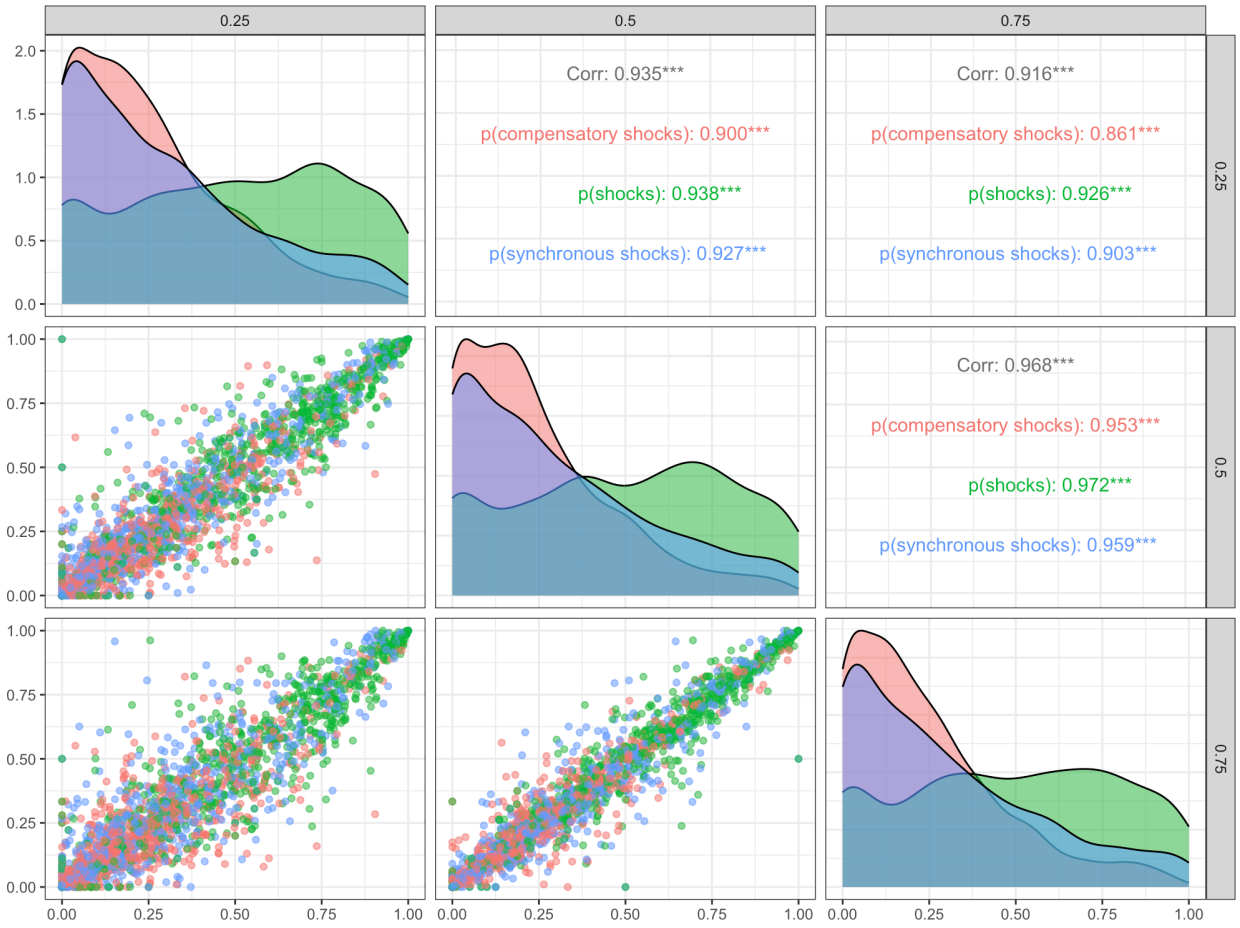
Supplementary Figure 7: Latitudinal gradients by exposure type corresponding to the maps on Figure 3. The gradients were generated by fitting a loess smoother with a span of 0.35 on the indicator values along the latitudinal axis. Each polygon on the world maps was associated with its centroid latitude value.



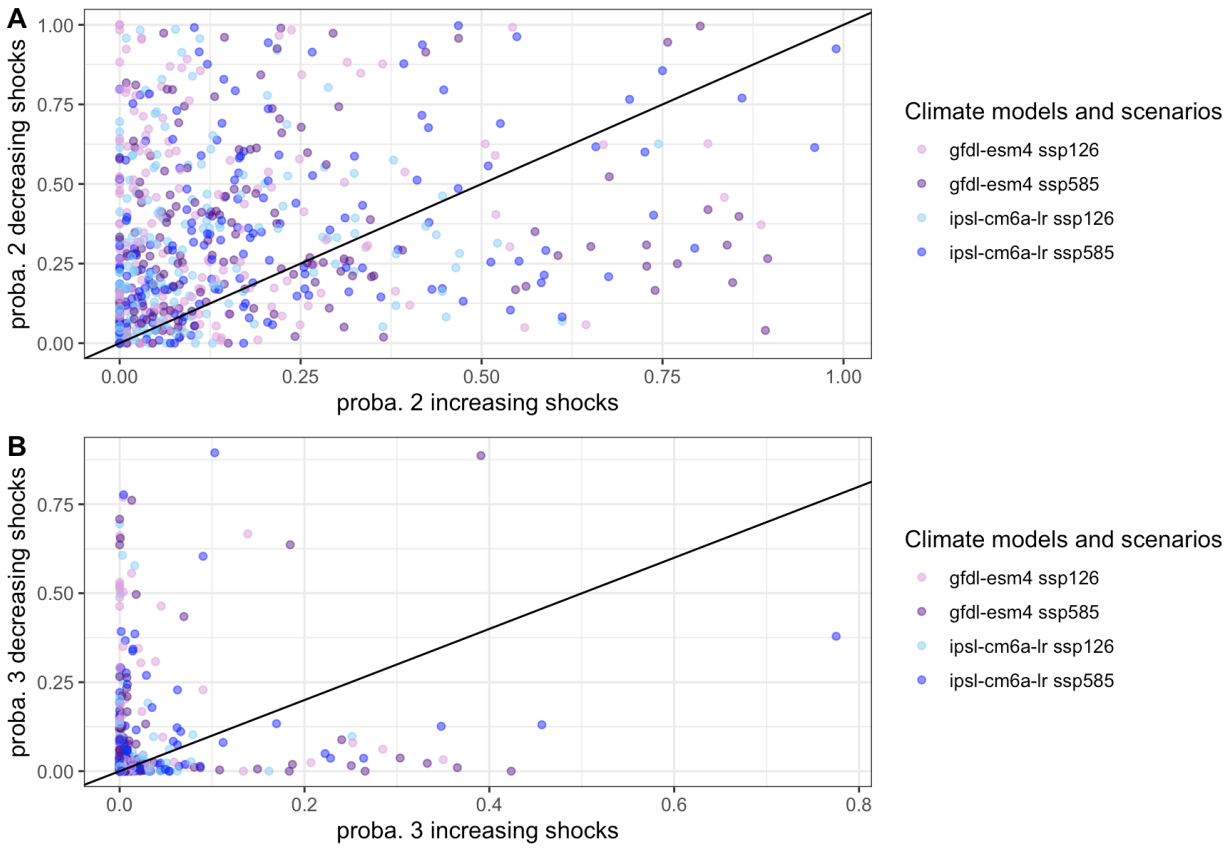
Supplementary Figure 8: Spatial distribution of synchronous and compensatory exposures to cross-sector climate impacts for SSP 1-2.6. Synchronous exposure was measured with: (A) the probability of at least one year with at least two decreasing shocks by the end of the century (2070-2100), and (B) the probability of at least two resources decreasing by 25% or more at the end of the century. Compensatory exposure was measured with: (C) the probability of at least one year with at least one increasing shock and at least one decreasing shock, and (D) the probability of at least one resource increasing by 25% or more and at least one resource decreasing by 25% or more. Each map shows the average probability across climate models for SSP 1-2.6. The geographic delineation merges national land and exclusive economic zones[4].



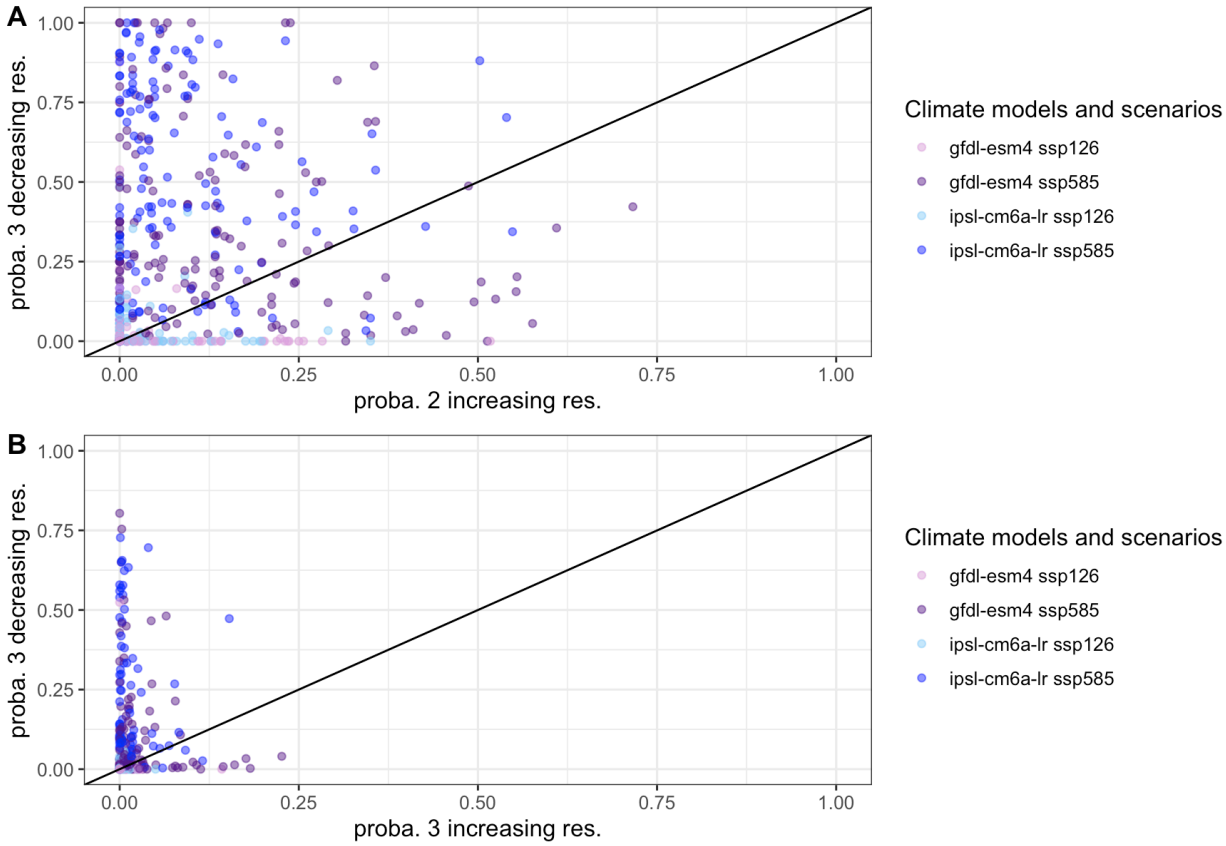
Supplementary Figure 9: Country exposure to cross-sector climate impacts compared to the respective regional trade agreement (RTAs) in complement to Figure 5B.



Supplementary Figure 10: Correlation between shock probability metrics across smooth span parameters. Shocks are detected by detrending the time-series with a loess smoother for which a span parameter can be adjusted (see Methods). We tested the sensitivity of the shock probability metrics to the span parameter values of 0.25, 0.5, and 0.75. For each span parameter value, we test the correlation for each shock probability metric: probability of at least one year with at least two shocks, probability of at least one year with two decreasing shocks (i.e., synchronous shocks), and probability of at least one year with at least one increasing shock and at least one decreasing shock (i.e., compensatory shocks) for all countries of the world, shared socio-economic pathways, and climate models.



Supplementary Figure 11: Visualization of the shock probability independence for the compensation metric. Each graph shows the relationship between the probabilities of at least one year with at least two (A) and at least three (B) increasing or decreasing shocks. Each dot on the graph represents a country for a climate model and climate scenario. Probability of at least three shocks is never high for increasing and decreasing shocks. The black solid line shows the 1-to-1 line.



Supplementary Figure 12: Visualization of the gradual probability independence hypothesis for the compensation metric. Each graph shows the relationship between the probabilities of at least two (A) or three (B) resources increasing or decreasing by 25%or more. Each dot on the graph represents a country for a climate model and climate scenario. Probability of at least three resources changing by 25% or more is never high for increasing and decreasing resources. The black solid line shows the 1-to-1 line.

Supplementary references

1. Jägermeyr, J. *et al.* ISIMIP3b Simulation Data from the Agriculture Sector. ISIMIP Repository https://doi.org/10.48364/ISIMIP.723340.2 (2024).
2. Novaglio, C. *et al.* Data and code for FishMIP global marine ecosystem model ensemble projections summarised by countries and territories and other selected marine spatial regions. Zenodo https://doi.org/10.5281/zenodo.13988998 (2024).
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4. Flanders Marine Institute (VLIZ), Belgium. The union of world country boundaries and EEZ's, version 3. Marine Data Archive https://doi.org/10.14284/403 (2020).