**The relationships between biotic uniqueness and environmental uniqueness are context dependent across drainage basins worldwide**

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## **Supplementary Information 2 S1. Spatial autocorrelation in local contribution to beta diversity (LCBD) and local contribution to environmental heterogeneity (LCEH) values for each drainage basin.**

## **S1. Spatial autocorrelation in the variables local contribution to beta diversity (LCBD) and local contribution to environmental heterogeneity (LCEH) for each drainage basin.**

**Table S1.** Moran’s Ifor local contribution to beta diversity (LCBD) values for each drainage basin. Statistically significant (p ≤ 0.05) results are shown in bold.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Spatial autocorrelation in LCBD values** | | | | | |
| Dataset | Moran I statistic standard deviate | p-value | Global Moran I statistic | Expectation | Variance |
| Ain | -1.170 | 0.879 | -0.269 | -0.053 | 0.034 |
| Doubs | 2.553 | **0.005** | 0.455 | -0.053 | 0.040 |
| Durance | 2.185 | 0.014 | 0.221 | -0.053 | 0.016 |
| Thur | 0.095 | 0.462 | -0.039 | -0.053 | 0.021 |
| Kinzig | -2.211 | 0.987 | -0.228 | -0.053 | 0.006 |
| Iijoki | -0.114 | 0.545 | -0.078 | -0.053 | 0.050 |
| Isère | -1.526 | 0.937 | -0.367 | -0.053 | 0.043 |
| Koutajoki | 1.087 | 0.138 | 0.156 | -0.053 | 0.037 |
| Mekong | -0.052 | 0.521 | -0.062 | -0.053 | 0.035 |
| Yarlung Tsangpo | 1.369 | 0.085 | 0.216 | -0.053 | 0.038 |
| Hanjiang | 2.754 | **0.003** | 0.491 | -0.053 | 0.039 |
| Paranapanema | -1.080 | 0.860 | -0.247 | -0.053 | 0.032 |
| Araguari | -0.881 | 0.811 | -0.163 | -0.053 | 0.016 |
| Gurupi | -0.108 | 0.543 | -0.074 | -0.053 | 0.038 |
| Guama | -0.314 | 0.623 | -0.076 | -0.053 | 0.005 |
| South Platte | 1.048 | 0.147 | 0.087 | -0.053 | 0.018 |
| Napo | -1.090 | 0.862 | -0.206 | -0.053 | 0.020 |
| Qiantang | -1.063 | 0.856 | -0.215 | -0.053 | 0.023 |
| Chinsui | -1.272 | 0.898 | -0.210 | -0.053 | 0.015 |
| Parnaíba | -1.016 | 0.845 | -0.244 | -0.053 | 0.036 |
| Saône | 0.815 | 0.208 | 0.066 | -0.053 | 0.021 |
| Elbe | 1.163 | 0.123 | 0.122 | -0.053 | 0.022 |
| Aude | 1.489 | 0.068 | 0.112 | -0.053 | 0.012 |
| Segura | 2.040 | **0.021** | 0.241 | -0.053 | 0.021 |
| Southern Morava | -0.529 | 0.701 | -0.105 | -0.053 | 0.010 |
| Aidge | 5.144 | **< 0.001** | 0.767 | -0.053 | 0.025 |
| Tenojoki | 0.106 | 0.458 | -0.040 | -0.053 | 0.014 |
| São Francisco | 0.846 | 0.199 | 0.096 | -0.053 | 0.031 |
| Grande | 0.935 | 0.175 | 0.154 | -0.053 | 0.049 |
| Wei | 0.166 | 0.434 | -0.032 | -0.053 | 0.016 |
| Yuqu | -0.643 | 0.740 | -0.190 | -0.053 | 0.046 |
| Betione | -0.454 | 0.675 | -0.089 | -0.053 | 0.007 |
| Orinoco | 2.380 | **0.009** | 0.572 | -0.053 | 0.069 |
| Acará | 1.172 | 0.121 | 0.163 | -0.053 | 0.034 |
| Amazon | -0.478 | 0.684 | -0.139 | -0.053 | 0.032 |
| Formoso | 0.020 | 0.492 | -0.049 | -0.053 | 0.041 |
| Rhine | -0.659 | 0.745 | -0.155 | -0.053 | 0.024 |
| Bükkösdi-víz | -0.581 | 0.719 | -0.109 | -0.053 | 0.010 |
| Pará | -0.112 | 0.545 | -0.072 | -0.053 | 0.031 |
| Chipiriri | 0.238 | 0.406 | -0.008 | -0.053 | 0.035 |
| Croton | -0.215 | 0.585 | -0.093 | -0.053 | 0.036 |
| Dalälven | 0.212 | 0.416 | -0.016 | -0.053 | 0.030 |

## **Table S2.** Moran’s Ifor local contribution to climate heterogeneity (LCEHclimate) values in each drainage basin. Statistically significant (p ≤ 0.05) results are shown in bold.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Spatial autocorrelation in LCEHclimate values** | | | | | |
| Dataset | Moran I statistic standard deviate | p-value | Moran I statistic | Expectation | Variance |
| Ain | 2.118 | **0.017** | 0.339 | -0.053 | 0.034 |
| Doubs | 1.281 | 0.100 | 0.152 | -0.053 | 0.026 |
| Durance | 0.259 | 0.398 | -0.019 | -0.053 | 0.016 |
| Thur | 5.226 | **< 0.001** | 0.748 | -0.053 | 0.023 |
| Kinzig | -1.621 | 0.947 | -0.142 | -0.053 | 0.003 |
| Iijoki | 3.759 | **< 0.001** | 0.820 | -0.053 | 0.054 |
| Isère | 1.628 | 0.052 | 0.308 | -0.053 | 0.049 |
| Koutajoki | 1.161 | 0.123 | 0.172 | -0.053 | 0.038 |
| Mekong | -0.793 | 0.786 | -0.219 | -0.053 | 0.044 |
| Yarlung Tsangpo | 1.589 | 0.056 | 0.217 | -0.053 | 0.029 |
| Hanjiang | 0.433 | 0.332 | -0.011 | -0.053 | 0.009 |
| Paranapanema | 3.238 | **0.001** | 0.525 | -0.053 | 0.032 |
| Araguari | 2.128 | **0.017** | 0.202 | -0.053 | 0.014 |
| Gurupi | 0.819 | 0.207 | 0.106 | -0.053 | 0.037 |
| Guama | 2.217 | **0.013** | 0.105 | -0.053 | 0.005 |
| South Platte | 1.208 | 0.114 | 0.137 | -0.053 | 0.025 |
| Napo | 0.427 | 0.335 | 0.013 | -0.053 | 0.024 |
| Qiantang | 0.284 | 0.388 | -0.009 | -0.053 | 0.023 |
| Chinsui | 0.304 | 0.381 | -0.039 | -0.053 | 0.002 |
| Parnaíba | 1.657 | **0.049** | 0.261 | -0.053 | 0.036 |
| Saône | -0.038 | 0.515 | -0.056 | -0.053 | 0.007 |
| Elbe | -0.464 | 0.679 | -0.092 | -0.053 | 0.007 |
| Aude | 4.274 | **< 0.001** | 0.297 | -0.053 | 0.007 |
| Segura | 2.711 | **0.003** | 0.253 | -0.053 | 0.013 |
| Southern Morava | -0.413 | 0.660 | -0.076 | -0.053 | 0.003 |
| Aidge | -0.283 | 0.612 | -0.094 | -0.053 | 0.021 |
| Tenojoki | 4.456 | **< 0.001** | 0.496 | -0.053 | 0.015 |
| São Francisco | 1.362 | 0.087 | 0.181 | -0.053 | 0.029 |
| Grande | 0.844 | 0.199 | 0.142 | -0.053 | 0.053 |
| Wei | 1.253 | 0.105 | 0.136 | -0.053 | 0.023 |
| Yuqu | 3.086 | **0.001** | 0.609 | -0.053 | 0.046 |
| Betione | 2.477 | **0.007** | 0.138 | -0.053 | 0.006 |
| Orinoco | 3.345 | **< 0.001** | 0.781 | -0.053 | 0.062 |
| Acará | 1.168 | 0.122 | 0.161 | -0.053 | 0.033 |
| Amazon | 1.777 | **0.038** | 0.229 | -0.053 | 0.025 |
| Formoso | 3.219 | **0.001** | 0.552 | -0.053 | 0.035 |
| Rhine | -0.408 | 0.658 | -0.115 | -0.053 | 0.024 |
| Bükkösdi-víz | 3.186 | **0.001** | 0.222 | -0.053 | 0.007 |
| Pará | 4.985 | **< 0.001** | 0.771 | -0.053 | 0.027 |
| Chipiriri | 2.113 | **0.017** | 0.347 | -0.053 | 0.036 |
| Croton | 2.307 | **0.011** | 0.384 | -0.053 | 0.036 |
| Dalälven | 3.707 | **< 0.001** | 0.539 | -0.053 | 0.026 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Spatial autocorrelation in LCEHlanduse values** | | | | | |
| Dataset | Moran I statistic standard deviate | p-value | Moran I statistic | Expectation | Variance |
| Ain | 1.471 | 0.071 | 0.210 | -0.053 | 0.032 |
| Doubs | 1.653 | **0.049** | 0.185 | -0.053 | 0.021 |
| Durance | 1.094 | 0.137 | 0.075 | -0.053 | 0.014 |
| Thur | -1.634 | 0.949 | -0.273 | -0.053 | 0.018 |
| Kinzig | -0.555 | 0.711 | -0.096 | -0.053 | 0.006 |
| Iijoki | -0.389 | 0.651 | -0.130 | -0.053 | 0.039 |
| Isère | 1.409 | 0.079 | 0.254 | -0.053 | 0.047 |
| Koutajoki | -0.503 | 0.693 | -0.128 | -0.053 | 0.023 |
| Mekong | -0.620 | 0.732 | -0.103 | -0.053 | 0.007 |
| Yarlung Tsangpo | 0.450 | 0.326 | 0.026 | -0.053 | 0.031 |
| Hanjiang | -0.889 | 0.813 | -0.204 | -0.053 | 0.029 |
| Paranapanema | -1.228 | 0.890 | -0.241 | -0.053 | 0.023 |
| Araguari | 1.758 | **0.039** | 0.021 | -0.053 | 0.002 |
| Gurupi | -0.268 | 0.606 | -0.097 | -0.053 | 0.027 |
| Guama | 0.455 | 0.324 | -0.025 | -0.053 | 0.004 |
| South Platte | -0.834 | 0.798 | -0.131 | -0.053 | 0.009 |
| Napo | -0.237 | 0.594 | -0.088 | -0.053 | 0.022 |
| Qiantang | 1.221 | 0.111 | 0.148 | -0.053 | 0.027 |
| Chinsui | 0.311 | 0.378 | -0.016 | -0.053 | 0.014 |
| Parnaíba | 0.294 | 0.385 | -0.009 | -0.053 | 0.022 |
| Saône | -0.489 | 0.688 | -0.107 | -0.053 | 0.012 |
| Elbe | 4.364 | **< 0.001** | 0.451 | -0.053 | 0.013 |
| Aude | 1.367 | 0.086 | 0.079 | -0.053 | 0.009 |
| Segura | 0.944 | 0.173 | 0.051 | -0.053 | 0.012 |
| Southern Morava | 0.946 | 0.172 | 0.031 | -0.053 | 0.008 |
| Aidge | 1.133 | 0.129 | 0.138 | -0.053 | 0.028 |
| Tenojoki | 0.023 | 0.491 | -0.050 | -0.053 | 0.014 |
| São Francisco | 1.535 | 0.062 | 0.269 | -0.053 | 0.044 |
| Grande | -0.784 | 0.784 | -0.191 | -0.053 | 0.031 |
| Wei | 0.879 | 0.190 | 0.061 | -0.053 | 0.017 |
| Yuqu | 0.015 | 0.494 | -0.050 | -0.053 | 0.044 |
| Betione | 0.205 | 0.419 | -0.040 | -0.053 | 0.004 |
| Orinoco | 0.052 | 0.479 | -0.046 | -0.053 | 0.014 |
| Acará | 0.624 | 0.266 | 0.067 | -0.053 | 0.037 |
| Amazon | -0.340 | 0.633 | -0.103 | -0.053 | 0.022 |
| Formoso | -0.036 | 0.514 | -0.059 | -0.053 | 0.033 |
| Rhine | -1.042 | 0.851 | -0.164 | -0.053 | 0.012 |
| Bükkösdi-víz | 0.523 | 0.300 | < 0.001 | -0.053 | 0.010 |
| Pará | -0.914 | 0.820 | -0.184 | -0.053 | 0.021 |
| Chipiriri | -0.963 | 0.832 | -0.091 | -0.053 | 0.002 |
| Croton | -0.810 | 0.791 | -0.184 | -0.053 | 0.026 |
| Dalälven | 1.895 | **0.029** | 0.128 | -0.053 | 0.009 |

## **Table S3.** Moran’s I for local contribution to land-use heterogeneity (LCEHlanduse) in each drainage basin. Statistically significant (p ≤ 0.05) results are shown in bold.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Spatial autocorrelation LCEHposition** | | | | | |
| Dataset | Moran I statistic standard deviate | p-value | Moran I statistic | Expectation | Variance |
| Ain | 0.367 | 0.357 | 0.003 | -0.053 | 0.023 |
| Doubs | -1.013 | 0.845 | -0.252 | -0.053 | 0.039 |
| Durance | 0.391 | 0.652 | -0.093 | -0.053 | 0.011 |
| Thur | 2.563 | **0.005** | 0.343 | -0.053 | 0.024 |
| Kinzig | -1.080 | 0.860 | -0.089 | -0.053 | 0.001 |
| Iijoki | -0.576 | 0.718 | -0.186 | -0.053 | 0.053 |
| Isère | -0.360 | 0.641 | -0.134 | -0.053 | 0.051 |
| Koutajoki | 1.135 | 0.128 | 0.035 | -0.053 | 0.006 |
| Mekong | 0.041 | 0.484 | -0.048 | -0.053 | 0.013 |
| Yarlung Tsangpo | 0.941 | 0.173 | 0.101 | -0.053 | 0.027 |
| Hanjiang | -0.210 | 0.583 | -0.086 | -0.053 | 0.025 |
| Paranapanema | 0.797 | 0.213 | 0.022 | -0.053 | 0.009 |
| Araguari | 0.437 | 0.331 | -0.021 | -0.053 | 0.005 |
| Gurupi | 0.369 | 0.356 | -0.015 | -0.053 | 0.010 |
| Guama | -0.761 | 0.777 | -0.078 | -0.053 | 0.001 |
| South Platte | -0.372 | 0.645 | -0.068 | -0.053 | 0.002 |
| Napo | 1.436 | 0.076 | 0.019 | -0.053 | 0.002 |
| Qiantang | 0.970 | 0.166 | 0.092 | -0.053 | 0.022 |
| Chinsui | 0.830 | 0.203 | 0.009 | -0.053 | 0.006 |
| Parnaíba | -0.113 | 0.545 | -0.070 | -0.053 | 0.024 |
| Saône | 0.387 | 0.350 | -0.007 | -0.053 | 0.014 |
| Elbe | 5.449 | **< 0.001** | 0.646 | -0.053 | 0.016 |
| Aude | 0.729 | 0.233 | 0.008 | -0.053 | 0.007 |
| Segura | 2.575 | 0.005 | 0.300 | -0.053 | 0.019 |
| Southern Morava | -1.319 | 0.906 | -0.142 | -0.053 | 0.005 |
| Aidge | 4.408 | **< 0.001** | 0.667 | -0.053 | 0.027 |
| Tenojoki | -0.188 | 0.574 | -0.073 | -0.053 | 0.012 |
| São Francisco | 0.348 | 0.364 | 0.018 | -0.053 | 0.042 |
| Grande | -0.442 | 0.671 | -0.136 | -0.053 | 0.036 |
| Wei | 4.734 | **< 0.001** | 0.632 | -0.053 | 0.021 |
| Yuqu | 2.209 | **0.014** | 0.425 | -0.053 | 0.047 |
| Betione | 0.679 | 0.249 | -0.006 | -0.053 | 0.005 |
| Orinoco | 2.710 | **0.003** | 0.203 | -0.053 | 0.009 |
| Acará | -0.227 | 0.590 | -0.082 | -0.053 | 0.016 |
| Amazon | -0.157 | 0.562 | -0.077 | -0.053 | 0.024 |
| Formoso | 1.915 | **0.028** | 0.106 | -0.053 | 0.007 |
| Rhine | -0.224 | 0.589 | -0.078 | -0.053 | 0.013 |
| Bükkösdi-víz | -0.810 | 0.791 | -0.132 | -0.053 | 0.010 |
| Pará | -0.268 | 0.606 | -0.091 | -0.053 | 0.021 |
| Chipiriri | -1.183 | 0.882 | -0.125 | -0.053 | 0.004 |
| Croton | 0.251 | 0.401 | -0.007 | -0.053 | 0.033 |
| Dalälven | 1.966 | **0.025** | 0.079 | -0.053 | 0.004 |

## **Table S4.** Moran’s Ifor local contribution to stream site position heterogeneity (LCEHposition) in each drainage basin. Statistically significant (p ≤ 0.05) results are shown in bold.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Spatial autocorrelation in LCEHsoil values** | | | | | |
| Dataset | Moran I statistic standard deviate | p-value | Moran I statistic | Expectation | Variance |
| Ain | 1.648 | **0.050** | 0.167 | -0.053 | 0.018 |
| Doubs | 2.515 | **0.006** | 0.432 | -0.053 | 0.037 |
| Durance | -0.213 | 0. 584 | -0.080 | -0.053 | 0.016 |
| Thur | -0.539 | 0.705 | -0.129 | -0.053 | 0.020 |
| Kinzig | - 1.222 | 0.889 | -0.149 | -0.053 | 0.006 |
| Iijoki | -0.435 | 0.668 | -0.143 | -0.053 | 0.043 |
| Isère | 0.887 | 0.188 | 0.131 | -0.053 | 0.043 |
| Koutajoki | 1.205 | 0.114 | 0.175 | -0.053 | 0.036 |
| Mekong | -1.192 | 0.883 | -0.161 | -0.053 | 0.008 |
| Yarlung Tsangpo | 0.832 | 0.203 | 0.099 | -0.053 | 0.033 |
| Hanjiang | -0.551 | 0.709 | -0.154 | -0.053 | 0.034 |
| Paranapanema | 0.512 | 0.304 | 0.026 | -0.053 | 0.024 |
| Araguari | 2.025 | **0.021** | 0.170 | -0.053 | 0.012 |
| Gurupi | -0.410 | 0.659 | -0.130 | -0.053 | 0.036 |
| Guama | -1.741 | 0.959 | -0.180 | -0.053 | 0.005 |
| South Platte | 3.532 | **< 0.001** | 0.534 | -0.053 | 0.028 |
| Napo | -0.399 | 0.655 | -0.106 | -0.053 | 0.018 |
| Qiantang | 1.075 | 0.141 | 0.090 | -0.053 | 0.018 |
| Chinsui | 3.531 | **< 0.001** | 0.381 | -0.053 | 0.015 |
| Parnaíba | -0.554 | 0.710 | -0.155 | -0.053 | 0.034 |
| Saône | 0.112 | 0.456 | -0.037 | -0.053 | 0.019 |
| Elbe | -0.198 | 0.578 | -0.076 | -0.053 | 0.014 |
| Aude | 2.097 | **0.018** | 0.175 | -0.053 | 0.012 |
| Segura | 1.419 | 0.078 | 0.128 | -0.053 | 0.016 |
| Southern Morava | -0.216 | 0.586 | -0.074 | -0.053 | 0.010 |
| Aidge | 4.757 | **< 0.001** | 0.727 | -0.053 | 0.027 |
| Tenojoki | 0.846 | 0.199 | 0.053 | -0.053 | 0.015 |
| São Francisco | 1.904 | **0.028** | 0.265 | -0.053 | 0.028 |
| Grande | 0.591 | 0.277 | 0.038 | -0.053 | 0.023 |
| Wei | 1.828 | 0.034 | 0.223 | -0.053 | 0.023 |
| Yuqu | -0.430 | 0.666 | -0.109 | -0.053 | 0.017 |
| Betione | 0.201 | 0.421 | -0.038 | -0.053 | 0.005 |
| Orinoco | 2.416 | **0.008** | 0.578 | -0.053 | 0.068 |
| Acará | -1.609 | 0.946 | -0.359 | -0.053 | 0.036 |
| Amazon | 2.811 | **0.002** | 0.400 | -0.053 | 0.026 |
| Formoso | 0.433 | 0.332 | 0.029 | -0.053 | 0.035 |
| Rhine | -1.627 | 0.948 | -0.297 | -0.053 | 0.023 |
| Bükkösdi-víz | 2.405 | **0.008** | 0.212 | -0.053 | 0.012 |
| Pará | 5.2207 | **< 0.001** | 0.843 | -0.053 | 0.030 |
| Chipiriri | -0.209 | 0.583 | -0.064 | -0.053 | 0.003 |
| Croton | 0.624 | 0.266 | 0.024 | -0.053 | 0.015 |
| Dalälven | -0.011 | 0.505 | -0.054 | -0.053 | 0.028 |

## **Table S5.** Moran’s Ifor local contribution to soil heterogeneity (LCEHsoil) values in each drainage basin. Statistically significant (p ≤ 0.05) results are shown in bold.

## **Supplementary Information 2 S2. Ranges of observed values of local contribution to beta diversity (LCBD) and local contribution to environmental heterogeneity (LCEH) in each drainage basins.**

## **Table S6.** Ranges in values oflocal contribution to beta diversity (LCBD) and local contribution to environmental heterogeneity (LCEH) for each drainage basin. Calculation of LCEH was based on four different sets of environmental variables. Minimum (min), maximum (max), and standard deviation (SD) of LCBD and LCEH values are shown.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **LCBD and LCEH values min-max (SD)** | | | | | |
| **Dataset** | **LCBD** | **LCEHclimate** | **LCEHlanduse** | **LCEHsoil** | **LCEHposition** |
| Ain | 0.023-0.085 (0.015) | 0.006-0.155  (0.042) | 0.005-0.232  (0.067) | 0.005-0.261  (0.056) | < 0.001-0.242  (0.055) |
| Paranapanema | 0.028-0.079  (0.015) | 0.006-0.141  (0.044) | 0.006-0.261  (0.072) | 0.006-0.165  (0.035) | 0.002-0.445  (0.097) |
| Aude | 0.032-0.072  (0.011) | 0.002-0.327  (0.075) | 0.005-0.241  (0.058) | < 0.001-0.172  (0.048) | 0.003-0.436  (0.108) |
| Betione | 0.015-0.112  (0.026) | 0.002-0.139  (0.032) | 0.001-0.285  (0.065) | 0.002-0.271  (0.071) | 0.004-0.252  (0.066) |
| Bükkösdi-víz | 0.021-0.134  (0.029) | 0.027-0.179  (0.036) | 0.005-0.259  (0.070) | 0.002-0.127  (0.039) | 0.004-0.217  (0.057) |
| Pará | 0.029-0.089  (0.016) | 0.006-0.207  (0.059) | 0.002-0.417  (0.104) | 0.005-0.168  (0.044) | 0.002-0.326  (0.080) |
| Chipiriri | 0.028-0.087  (0.016) | 0.004-0.145  (0.045) | 0.002-0.683  (0.147) | 0.004-0.472  (0.098) | 0.001-0.489  (0.103) |
| Croton | 0.015-0.124  (0.027) | 0.004-0.182  (0.049) | 0.004-0.294  (0.071) | 0.001-0.356  (0.078) | < 0.001-0.229  (0.063) |
| Dalälven | 0.022-0.089  (0.018) | 0.006-0.176  (0.047) | 0.002-0.577  (0.131) | 0.004-0.148  (0.038) | 0.003-0.474  (0.101) |
| Doubs | 0.029-0.092  (0.017) | 0.002-0.241  (0.054) | 0.011-0.201  (0.040) | 0.001-0.180  (0.048) | 0.006-0.214  (0.066) |
| Durance | 0.025-0.097  (0.017) | 0.008-0.126  (0.029) | 0.015-0.171  (0.038) | < 0.001-0.211  (0.057) | < 0.001-0.262  (0.059) |
| Thur | 0.011-0.090  (0.018) | 0.012-0.097  (0.028) | 0.005-0.194  (0.046) | 0.006-0.196  (0.052) | 0.001-0.111  (0.035) |
| Kinzing | 0.031-0.086  (0.017) | 0.007-0.291  (0.064) | 0.007-0.147  (0.046) | < 0.001-0.200  (0.065) | 0.003-0.411  (0.086) |
| Iijoki | 0.013-0.105  (0.022) | 0.005-0.102  (0.029) | 0.003-0.291  (0.074) | 0.006-0.213  (0.054) | < 0.001-0.126  (0.040) |
| Isère | 0.015-0.112  (0.021) | 0.004-0.136  (0.042) | 0.008-0.129  (0.032) | 0.004-0.196  (0.056) | 0.001-0.109  (0.031) |
| Kouta | 0.021-0.098  (0.017) | 0.009-0.153  (0.040) | 0.003-0.343  (0.080) | 0.001-0.233  (0.064) | 0.001-0.496  (0.106) |
| Mekong | 0.028-0.129  (0.024) | 0.003-0.173  (0.043) | 0.002-0.587  (0.127) | 0.003-0.545  (0.118) | 0.002-0.525  (0.116) |
| Yarlung Tsangbo | 0.032-0.078  (0.013) | 0.004-0.169  (0.036) | 0.006-0.192  (0.053) | 0.012-0.146  (0.038) | 0.003-0.259  (0.072) |
| Chishui | 0.028-0.092  (0.017) | 0.002-0.425  (0.088) | 0.008-0.195  (0.055) | 0.006-0.177  (0.050) | < 0.001-0.481  (0.109) |
| Hanjiang | 0.025-0.089  (0.019) | 0.001-0.475  (0.103) | 0.016-0.202  (0.053) | 0.011-0.154  (0.038) | < 0.001-0.293  (0.081) |
| Araguari | 0.033-0.063  (0.009) | 0.008-0.148  (0.044) | 0.002-0.561  (0.120) | 0.009-0.200  (0.048) | 0.001-0.356  (0.076) |
| Gurupi | 0.031-0.092  (0.018) | 0.008-0.128  (0.031) | 0.002-0.307  (0.081) | 0.007-0.171  (0.046) | 0.003-0.349  (0.073) |
| Capim | 0.024-0.093  (0.020) | 0.005-0.153  (0.040) | 0.001-0.285  (0.070) | 0.006-0.117  (0.032) | 0.004-0.402  (0.084) |
| South Platte | 0.021-0.134  (0.023) | 0.003-0.201  (0.057) | 0.005-0.654  (0.150) | 0.002-0.172  (0.050) | 0.001-0.575  (0.122) |
| Napo | 0.025-0.115  (0.026) | 0.010-0.124  (0.037) | 0.005-0.199  (0.060) | < 0.001-0.229  (0.056) | 0.004-0.457  (0.096) |
| Qiantang | 0.019-0.126  (0.025) | 0.001-0.211  (0.055) | 0.004-0.173  (0.051) | 0.003-0.201  (0.043) | 0.009-0.172  (0.038) |
| Parnaíba | 0.023-0.107  (0.024) | 0.004-0.124  (0.032) | 0.003-0.323  (0.076) | 0.006-0.152  (0.039) | 0.002-0.225  (0.050) |
| Saône | 0.025-0.086  (0.016) | 0.010-0.305  (0.063) | 0.006-0.245  (0.054) | 0.001-0.211  (0.060) | 0.002-0.354  (0.089) |
| Elbe | 0.032-0.074  (0.012) | 0.003-0.349  (0.074) | 0.008-0.255 (0.056) | 0.002-0.244  (0.054) | 0.003-0.331  (0.086) |
| Segura | 0.029-0.074  (0.015) | < 0.001-0.237  (0.053) | 0.005-0.240  (0.054) | 0.001-0.218  (0.057) | 0.004-0.161  (0.046) |
| Southern Morava | 0.029-0.077  (0.014) | 0.004-0.389  (0.084) | 0.008-0.215  (0.051) | 0.001-0.166  (0.051) | 0.001-0.439  (0.101) |
| Aidge | 0.029-0.103  (0.021) | 0.009-0.223  (0.058) | 0.007-0.123  (0.033) | 0.001-0.150  (0.046) | 0.003-0.197  (0.066) |
| Teno | 0.011-0.094  (0.018) | 0.003-0.120  (0.036) | 0.007-0.177  (0.046) | 0.002-0.129  (0.039) | 0.003-0.209  (0.050) |
| São Francisco | 0.023-0.119  (0.020) | 0.005-0.179  (0.036) | 0.003-0.160  (0.044) | 0.002-0.267  (0.060) | 0.007-0.161  (0.042) |
| Grande | 0.028-0.107  (0.021) | 0.014-0.112  (0.029) | 0.002-0.379  (0.093) | 0.008-0.246  (0.051) | 0.004-0.231  (0.054) |
| Wei | 0.038-0.111  (0.021) | 0.002-0.175  (0.049) | 0.005-0.232  (0.055) | 0.003-0.131  (0.037) | 0.006-0.165  (0.042) |
| Yuqu | 0.033-0.078  (0.012) | 0.006-0.161  (0.054) | 0.012-0.154  (0.043) | 0.002-0.439  (0.099) | 0.015-0.119  (0.034) |
| Orinoco | 0.035-0.070  (0.012) | 0.008-0.135  (0.036) | 0.010-0.348  (0.072) | 0.006-0.116  (0.040) | 0.015-0.359  (0.073) |
| Acará | 0.016-0.111  (0.021) | 0.001-0.155  (0.038) | 0.008-0.150  (0.041) | 0.004-0.144  (0.040) | < 0.001-0.369  (0.083) |
| Amazon | 0.025-0.094  (0.020) | 0.010-0.171  (0.037) | 0.003-0.316  (0.080) | 0.004-0.187  (0.043) | 0.003-0.256  (0.063) |
| Fromoso | 0.034-0.066  (0.010) | 0.005-0.180  (0.046) | 0.003-0.209  (0.055) | 0.006-0.202  (0.059) | 0.002-0.531  (0.115) |
| Rhine | 0.016-0.100  (0.025) | 0.002-0.122  (0.035) | 0.003-0.297  (0.065) | 0.002-0.160  (0.044) | < 0.001-0.398  (0.096) |

## **Appendix 2 S3. Modified t-tests.**

## **Table S7.** Modified t-tests results for the relationship between local contribution to beta diversity (LCBD) and local contribution to climate heterogeneity (LCEHclimate) in each drainage basin.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Modified t-test results LCBD-LCEHclimate** | | | | | |
| **Dataset** | **R** | **ESS** | **F** | **dof** | **p-value** |
| Ain | 0.341 | 63.468 | 0.132 | 61.468 | **0.006\*\*** |
| Paranapanema | -0.068 | 19.961 | 0.005 | 17.961 | 0.776 |
| Aude | 0.375 | 14.218 | 0.163 | 12.218 | 0.183 |
| Betione | 0.208 | 18.205 | 0.045 | 16.205 | 0.403 |
| Bükkösdi-víz | 0.173 | 18.480 | 0.031 | 16.480 | 0.487 |
| Pará | 0.476 | 15.453 | 0.293 | 13.453 | 0.068 |
| Chipiriri | 0.089 | 18.012 | 0.008 | 16.012 | 0.727 |
| Croton | 0.161 | 14.560 | 0.027 | 12.560 | 0.572 |
| Dalälven | 0.228 | 20.760 | 0.055 | 18.760 | 0.324 |
| Doubs | 0.165 | 20.815 | 0.028 | 18.815 | 0.477 |
| Durance | 0.476 | 16.377 | 0.293 | 14.377 | 0.059 |
| Thur | 0.377 | 14.110 | 0.165 | 12.110 | 0.182 |
| Kinzing | 0.541 | 20.163 | 0.413 | 18.163 | **0.013\*** |
| Iijoki | -0.460 | 14.491 | 0.269 | 12.491 | 0.091 |
| Isère | 0.147 | 19.748 | 0.022 | 17.748 | 0.538 |
| Kouta | 0.030 | 18.921 | 0.001 | 16.921 | 0.905 |
| Mekong | 0.723 | 18.855 | 1.096 | 16.855 | **<0.001\*\*** |
| Yarlung Tsangbo | 0.201 | 17.503 | 0.042 | 15.503 | 0.432 |
| Chishui | 0.078 | 24.023 | 0.006 | 22.023 | 0.716 |
| Han | -0.048 | 25.006 | 0.002 | 23.006 | 0.820 |
| Araguari | -0.143 | 25.841 | 0.021 | 23.841 | 0.488 |
| Gurupi | -0.080 | 20.672 | 0.006 | 18.672 | 0.733 |
| Capim | -0.041 | 21.095 | 0.002 | 19.095 | 0.860 |
| South Platte | -0.192 | 26.371 | 0.038 | 24.371 | 0.344 |
| Napo | 0.573 | 9.381 | 0.490 | 7.381 | 0.097 |
| Qiantang | 0.139 | 14.232 | 0.020 | 12.232 | 0.631 |
| Parnaíba | -0.068 | 34.216 | 0.005 | 32.216 | 0.703 |
| Saône | 0.317 | 21.903 | 0.111 | 19.903 | 0.152 |
| Elbe | 0.217 | 21.545 | 0.050 | 19.545 | 0.337 |
| Segura | 0.228 | 13.444 | 0.055 | 11.444 | 0.445 |
| Southern Morava | -0.046 | 21.803 | 0.002 | 19.803 | 0.838 |
| Aidge | 0.210 | 12.465 | 0.046 | 10.465 | 0.501 |
| Teno | -0.008 | 16.614 | <0.001 | 14.614 | 0.977 |
| São Francisco | 0.007 | 21.265 | <0.001 | 19.265 | 0.975 |
| Grande | -0.071 | 14.438 | 0.005 | 12.438 | 0.807 |
| Wei | 0.190 | 24.090 | 0.038 | 22.090 | 0.372 |
| Yuqu | 0.336 | 28.958 | 0.127 | 26.958 | 0.075 |
| Orinoco | 0.102 | 19.437 | 0.010 | 17.437 | 0.675 |
| Acará | 0.243 | 13.832 | 0.063 | 11.832 | 0.406 |
| Amazon | -0.412 | 14.579 | 0.204 | 12.579 | 0.134 |
| Fromoso | -0.126 | 36.295 | 0.016 | 34.295 | 0.462 |
| Rhine | 0.157 | 16.946 | 0.025 | 14.946 | 0.548 |

## **Table S8.** Modified t-tests results for the relationship between local contribution to beta diversity (LCBD) and local contribution to land-use heterogeneity (LCEHlanduse) in each drainage basin.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Modified t-test results LCBD-LCEHlanduse** | | | | | |
| **Dataset** | **R** | **ESS** | **F** | **dof** | **p-value** |
| Ain | -0.169 | 21.437 | 0.030 | 19.437 | 0.457 |
| Paranapanema | 0.457 | 24.057 | 0.264 | 22.057 | **0.025\*** |
| Aude | 0.387 | 16.537 | 0.177 | 14.537 | 0.131 |
| Betione | -0.197 | 18.690 | 0.040 | 16.690 | 0.424 |
| Bükkösdi-víz | 0.380 | 22.399 | 0.168 | 20.399 | 0.078 |
| Pará | 0.201 | 17.520 | 0.042 | 15.520 | 0.432 |
| Chipiriri | -0.137 | 20.741 | 0.019 | 18.741 | 0.558 |
| Croton | 0.436 | 21.330 | 0.235 | 19.330 | **0.046\*** |
| Dalälven | 0.237 | 18.423 | 0.059 | 16.423 | 0.337 |
| Doubs | -0.047 | 12.017 | 0.002 | 10.017 | 0.886 |
| Durance | 0.052 | 15.948 | 0.003 | 13.948 | 0.847 |
| Thur | -0.007 | 21.129 | <0.001 | 19.129 | 0.976 |
| Kinzing | 0.174 | 23.743 | 0.031 | 21.743 | 0.420 |
| Iijoki | 0.205 | 19.171 | 0.044 | 17.171 | 0.398 |
| Isère | -0.264 | 18.230 | 0.075 | 16.230 | 0.286 |
| Kouta | 0.013 | 20.989 | <0.001 | 18.989 | 0.954 |
| Mekong | 0.045 | 19.242 | 0.002 | 17.242 | 0.855 |
| Yarlung Tsangbo | -0.325 | 19.928 | 0.118 | 17.928 | 0.163 |
| Chishui | 0.289 | 16.652 | 0.091 | 14.652 | 0.267 |
| Han | 0.301 | 12.741 | 0.100 | 10.741 | 0.323 |
| Araguari | 0.258 | 22.050 | 0.072 | 20.050 | 0.245 |
| Gurupi | 0.191 | 20.318 | 0.038 | 18.318 | 0.416 |
| Capim | 0.473 | 19.854 | 0.288 | 17.854 | **0.036\*** |
| South Platte | -0.054 | 22.014 | 0.003 | 20.014 | 0.811 |
| Napo | 0.403 | 20.170 | 0.194 | 18.170 | **0.077\*** |
| Qiantang | 0.210 | 69.820 | 0.046 | 67.820 | 0.081 |
| Parnaíba | 0.035 | 42.923 | 0.001 | 40.923 | 0.826 |
| Saône | 0.493 | 18.625 | 0.322 | 16.625 | **0.034\*** |
| Elbe | 0.627 | 13.613 | 0.649 | 11.613 | **0.018\*** |
| Segura | 0.214 | 24.836 | 0.048 | 22.836 | 0.306 |
| Southern Morava | -0.110 | 15.902 | 0.012 | 13.902 | 0.687 |
| Aidge | 0.223 | 24.304 | 0.052 | 22.304 | 0.292 |
| Teno | 0.092 | 30.748 | 0.009 | 28.748 | 0.625 |
| São Francisco | -0.114 | 23.637 | 0.013 | 21.637 | 0.600 |
| Grande | -0.309 | 14.545 | 0.106 | 12.545 | 0.271 |
| Wei | 0.658 | 15.821 | 0.762 | 13.821 | **0.006\*\*** |
| Yuqu | 0.189 | 21.059 | 0.037 | 19.059 | 0.412 |
| Orinoco | 0.412 | 22.609 | 0.205 | 20.609 | 0.053 |
| Acará | -0.315 | 20.729 | 0.110 | 18.729 | 0.168 |
| Amazon | 0.287 | 22.865 | 0.090 | 20.865 | 0.186 |
| Fromoso | -0.031 | 16.746 | 0.001 | 14.746 | 0.905 |
| Rhine | -0.312 | 19.994 | 0.108 | 17.994 | 0.181 |

## **Table S9.** Modified t-tests results for the relationship between local contribution to beta diversity (LCBD) and local contribution to stream site position heterogeneity (LCEHposition) in drainage basin.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Modified t-test results LCBD-LCEHposition** | | | | | |
| **Basin** | **R** | **ESS** | **F** | **dof** | **p-value** |
| Ain | 0.521 | 19.636 | 0.373 | 17.636 | **0.020\*** |
| Paranapanema | 0.248 | 21.217 | 0.066 | 19.217 | 0.276 |
| Aude | 0.223 | 13.612 | 0.052 | 11.612 | 0.452 |
| Betione | -0.023 | 22.734 | 0.001 | 20.734 | 0.916 |
| Bükkösdi-víz | -0.214 | 25.097 | 0.048 | 23.097 | 0.303 |
| Pará | 0.249 | 27.738 | 0.066 | 25.738 | 0.204 |
| Chipiriri | -0.136 | 23.025 | 0.019 | 21.025 | 0.537 |
| Croton | 0.540 | 16.694 | 0.411 | 14.694 | **0.027\*** |
| Dalälven | 0.202 | 20.878 | 0.042 | 18.878 | 0.382 |
| Doubs | 0.045 | 21.605 | 0.002 | 19.605 | 0.842 |
| Durance | -0.076 | 52.250 | 0.006 | 50.250 | 0.592 |
| Thur | 0.060 | 26.504 | 0.004 | 24.504 | 0.770 |
| Kinzing | 0.439 | 23.254 | 0.238 | 21.254 | **0.035\*** |
| Iijoki | -0.487 | 15.970 | 0.311 | 13.970 | 0.056 |
| Isère | 0.070 | 17.887 | 0.005 | 15.887 | 0.784 |
| Kouta | 0.173 | 20.018 | 0.031 | 18.018 | 0.467 |
| Mekong | 0.121 | 18.722 | 0.015 | 16.722 | 0.624 |
| Yarlung Tsangbo | -0.182 | 21.342 | 0.034 | 19.342 | 0.426 |
| Chishui | -0.099 | 15.889 | 0.010 | 13.889 | 0.716 |
| Han | -0.051 | 20.080 | 0.003 | 18.080 | 0.831 |
| Araguari | 0.003 | 21.685 | <0.001 | 19.685 | 0.989 |
| Gurupi | 0.262 | 21.550 | 0.074 | 19.550 | 0.244 |
| Capim | -0.270 | 17.368 | 0.079 | 15.368 | 0.288 |
| South Platte | -0.080 | 19.793 | 0.006 | 17.793 | 0.740 |
| Napo | 0.675 | 11.729 | 0.839 | 9.729 | **0.018\*** |
| Qiantang | 0.082 | 22.428 | 0.007 | 20.428 | 0.715 |
| Parnaíba | 0.097 | 31.851 | 0.010 | 29.851 | 0.598 |
| Saône | 0.422 | 21.163 | 0.216 | 19.163 | 0.056 |
| Elbe | 0.482 | 15.675 | 0.302 | 13.675 | 0.062 |
| Segura | 0.302 | 10.970 | 0.100 | 8.970 | 0.368 |
| Southern Morava | -0.188 | 18.073 | 0.037 | 16.073 | 0.454 |
| Aidge | 0.880 | 5.437 | 3.427 | 3.437 | **0.034\*** |
| Teno | 0.139 | 21.544 | 0.020 | 19.544 | 0.543 |
| São Francisco | -0.015 | 17.268 | <0.001 | 15.268 | 0.953 |
| Grande | -0.071 | 22.846 | 0.005 | 20.846 | 0.748 |
| Wei | 0.225 | 17.739 | 0.053 | 15.739 | 0.374 |
| Yuqu | 0.338 | 20.826 | 0.129 | 18.826 | 0.136 |
| Orinoco | 0.304 | 25.641 | 0.102 | 23.641 | 0.134 |
| Acará | 0.042 | 24.531 | 0.002 | 22.531 | 0.843 |
| Amazon | -0.021 | 18.062 | <0.001 | 16.062 | 0.935 |
| Fromoso | -0.224 | 23.021 | 0.053 | 21.021 | 0.305 |
| Rhine | -0.457 | 20.956 | 0.264 | 18.956 | **0.037\*** |

## **Table S10.** Modified t-tests results for the relationship between local contribution to beta diversity (LCBD) and local contribution to soil heterogeneity (LCEHsoil) in each drainage basin.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Modified t-test results LCBD-LCEHsoil** | | | | | |
| **Dataset** | **R** | **ESS** | **F** | **dof** | **p-value** |
| Ain | 0.071 | 25.937 | 0.005 | 23.937 | 0.731 |
| Paranapanema | 0.279 | 19.016 | 0.084 | 17.016 | 0.248 |
| Aude | 0.292 | 24.869 | 0.093 | 22.869 | 0.157 |
| Betione | -0.234 | 26.116 | 0.058 | 24.116 | 0.249 |
| Bükkösdi-víz | 0.049 | 21.526 | 0.002 | 19.526 | 0.830 |
| Pará | 0.041 | 25.574 | 0.002 | 23.574 | 0.846 |
| Chipiriri | 0.309 | 18.433 | 0.106 | 16.433 | 0.206 |
| Croton | 0.079 | 24.071 | 0.006 | 22.071 | 0.714 |
| Dalälven | 0.237 | 18.251 | 0.060 | 16.251 | 0.339 |
| Doubs | 0.482 | 11.309 | 0.303 | 9.309 | 0.126 |
| Durance | 0.017 | 16.514 | <0.001 | 14.514 | 0.950 |
| Thur | 0.003 | 28.608 | <0.001 | 26.608 | 0.989 |
| Kinzing | 0.254 | 22.651 | 0.069 | 20.651 | 0.245 |
| Iijoki | -0.211 | 21.831 | 0.047 | 19.831 | 0.348 |
| Isère | -0.184 | 25.580 | 0.035 | 23.580 | 0.373 |
| Kouta | 0.219 | 21.558 | 0.051 | 19.558 | 0.332 |
| Mekong | -0.008 | 18.415 | <0.001 | 16.415 | 0.975 |
| Yarlung Tsangbo | -0.259 | 19.519 | 0.072 | 17.519 | 0.277 |
| Chishui | 0.001 | 50.166 | <0.001 | 48.166 | 0.997 |
| Han | 0.066 | 33.536 | 0.004 | 31.536 | 0.712 |
| Araguari | -0.262 | 23.265 | 0.074 | 21.265 | 0.225 |
| Gurupi | 0.021 | 19.336 | <0.001 | 17.336 | 0.930 |
| Capim | 0.118 | 24.695 | 0.014 | 22.695 | 0.576 |
| South Platte | -0.144 | 16.734 | 0.021 | 14.734 | 0.586 |
| Napo | 0.539 | 12.440 | 0.410 | 10.440 | 0.064 |
| Qiantang | -0.051 | 20.777 | 0.003 | 18.777 | 0.827 |
| Parnaíba | -0.039 | 17.553 | 0.002 | 15.553 | 0.880 |
| Saône | 0.471 | 16.059 | 0.286 | 14.059 | 0.065 |
| Elbe | 0.082 | 22.032 | 0.007 | 20.032 | 0.717 |
| Segura | 0.248 | 13.875 | 0.066 | 11.875 | 0.395 |
| Southern Morava | 0.352 | 18.747 | 0.141 | 16.747 | 0.142 |
| Aidge | -0.384 | 11.705 | 0.173 | 9.705 | 0.226 |
| Teno | 0.137 | 25.793 | 0.019 | 23.793 | 0.507 |
| São Francisco | -0.079 | 16.793 | 0.006 | 14.793 | 0.764 |
| Grande | -0.147 | 30.140 | 0.022 | 28.140 | 0.437 |
| Wei | 0.804 | 11.674 | 1.827 | 9.674 | **0.002\*\*** |
| Yuqu | -0.320 | 20.137 | 0.114 | 18.137 | 0.167 |
| Orinoco | 0.295 | 12.602 | 0.095 | 10.602 | 0.337 |
| Acará | 0.075 | 19.339 | 0.006 | 17.339 | 0.759 |
| Amazon | -0.253 | 27.516 | 0.068 | 25.516 | 0.199 |
| Fromoso | 0.154 | 21.922 | 0.024 | 19.922 | 0.494 |
| Rhine | 0.072 | 34.473 | 0.005 | 32.473 | 0.682 |

## **Appendix 2 S4. Mixed-effects meta-regressions**

## **Table S11.** Results ofmixed-effects meta-regressions explaining variation in the relationships between LCBD and different LCEH measures across drainage basins. Latitude, human footprint index (HFPI) and east-west continental masses were used as explanatory variables in the models. Different spatial structures were used for each model (see Materials and Methods in the main text for details).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Mixed effects meta-regression results** | | | | | | | | | |
| **Model** | **Explanatory variable** | **Estimate** | **se** | **Z-value** | **p-value** | **ci.lb** | **ci.ub** | **Spatial structure** | **AICc** |
| **LCBD-LCEHclimate** | Americas | 0.012 | 0.126 | 0.095 | 0.924 | -0.235 | 0.259 | Gaussian | 14.783 |
| Eurasia | 0.142 | 0.160 | 0.885 | 0.376 | -0.172 | 0.456 |
| Latitude | -0.001 | 0.003 | -0.307 | 0.759 | -0.007 | 0.005 |
| HFPI mean | 0.005 | 0.009 | 0.568 | 0.570 | -0.012 | 0.022 |
| **LCBD-LCEHlanduse** | Americas | 0.112 | 0.090 | 1.253 | 0.210 | -0.063 | 0.287 | Spherical | 27.250 |
| Eurasia | 0.039 | 0.135 | 0.287 | 0.774 | -0.226 | 0.304 |
| Latitude | 0.001 | 0.002 | 0.636 | 0.525 | -0.003 | 0.006 |
| HFPI mean | 0.004 | 0.007 | 0.553 | 0.580 | -0.010 | 0.018 |
| **LCBD-LCEHposition** | Americas | 0.040 | 0.098 | 0.414 | 0.679 | -0.151 | 0.232 | Linear | 28.791 |
| Eurasia | -0.124 | 0.134 | -0.924 | 0.356 | -0.386 | 0.139 |
| Latitude | 0.002 | 0.002 | 0.969 | 0.333 | -0.002 | 0.007 |
| HFPI mean | 0.010 | 0.007 | 1.310 | 0.190 | -0.005 | 0.024 |
| **LCBD-LCEHsoil** | Americas | -0.002 | 0.079 | -0.019 | 0.985 | -0.156 | 0.153 | No strong spatial autocorrelation | 16.960 |
| Eurasia | -0.066 | 0.118 | -0.562 | 0.574 | -0.297 | 0.164 |
| Latitude | 0.002 | 0.002 | 1.075 | 0.282 | -0.002 | 0.006 |
| HFPI mean | 0.004 | 0.006 | 0.596 | 0.551 | -0.009 | 0.016 |

## **Table S12.** Tests for residual heterogeneity in the final mixed-effects meta-regression models**.**

|  |  |  |
| --- | --- | --- |
| **Test for residual heterogeneity** | | |
| **Model** | **QE (df 38)** | **p-value** |
| **LCBD-LCEHclimate** | 37.595 | 0.488 |
| **LCBD-LCEHlanduse** | 51.905 | 0.066 |
| **LCBD-LCEHposition** | 50.777 | 0.080 |
| **LCBD-LCEHsoil** | 40.979 | 0.341 |

## **Appendix 2 S5. Differences in environmental heterogeneity between catchments (PERMDISP)**

## **Table S14.** Average (and range)of mean distance of sites from group centroids for standardized environmental data in each drainage basin. F and p-values are comparing significant differences among different drainage basins.

|  |  |  |
| --- | --- | --- |
| **Dataset** | **Country** | **Environment (Euclidean)** |
| **Ain** | France | 3.59 (1.61–6.8) |
| **Paranapanema** | Brazil | 3.23 (1.22–6.65) |
| **Aude** | France | 3.6 (1.68–9.06) |
| **Betione** | Brazil | 3.37 (1.97–5.59) |
| **Bükkösdi–víz** | Hungary | 3.38 (2.34–5.41) |
| **Pará** | Brazil | 3.42 (1.7–9.6) |
| **Chipiriri** | Bolivia | 3.36 (1.14–10.52) |
| **Croton** | USA | 3.56 (1.74–6.1) |
| **Dalälven** | Sweden | 3.33 (1.74–8.65) |
| **Doubs** | France | 3.77 (1.64–5.67) |
| **Durance** | France | 4.02 (2.48–7.08) |
| **Thur** | Switzerland | 3.4 (1.98–5.48) |
| **Kinzing** | Germany | 3.33 (1.77–7.12) |
| **Iijoki** | Finland | 3.66 (2.52–6.01) |
| **Isère** | France | 3.99 (1.83–5.83) |
| **Kouta** | Finland | 3.59 (1.69–8.17) |
| **Mekong** | China | 3.46 (1.47–13.09) |
| **Yarlung Tsangbo** | Tibet | 4 (1.78–7.67) |
| **Chishui** | China | 3.51 (1.86–7.22) |
| **Han** | China | 3.54 (1.97–7.16) |
| **Araguari** | Brazil | 3.3 (1.88–8.42) |
| **Gurupi** | Brazil | 3.37 (2.02–5.79) |
| **Capim** | Brazil | 3.16 (1.4–4.35) |
| **South Platte** | USA | 2.99 (1.37–7.88) |
| **Napo** | Ecuador | 3.69 (1.58–6.74) |
| **Qiantang** | China | 3.9 (1.81–6.64) |
| **Paranaíba** | Brazil | 3.57 (1.97–7.02) |
| **Saône** | France | 3.5 (2.02–7.59) |
| **Elbe** | Germany | 3.69 (1.88–7.62) |
| **Segura** | Spain | 3.7 (1.52–6.44) |
| **Southern Morava** | Serbia | 3.75 (1.44–6.27) |
| **Aidge** | Italy | 3.97 (2.2–6.66) |
| **Teno** | Finland | 3.66 (2.01–5.48) |
| **São Francisco** | Brazil | 3.69 (1.7–5.14) |
| **Grande** | Brazil | 3.32 (2.12–6.11) |
| **Wei** | China | 3.28 (1.59–5.47) |
| **Yuqu** | Tibet | 3.93 (2.61–6.58) |
| **Orinoco** | Colombia | 3.54 (2.1–8.34) |
| **Acará** | Brazil | 3.44 (2.37–5.07) |
| **Amazon** | Brazil | 3.3 (1.51–5.88) |
| **Fromoso** | Brazil | 3.29 (1.91–6.27) |
| **Rhine** | Germany | 3.46 (1.92–6.51) |
| **F** | | 0.047 |
| **p** | | 0.829 |