Extended Data Table 1 | List of local nature's contributions to people (NCP) included in this analysis

NCP	Source	Units	Original resolution	Realm
Nitrogen retention for water quality regulation	Chaplin-Kramer et al. 2019 (Ref. 10), InVEST (updated)	Kg/ha nitrogen retained * number of people downstream	10 arc-sec (~300 m)	Land
Sediment retention for water quality regulation	Chaplin Kramer et al., InVEST (new for this analysis)	T/ha sediment retained * number of people downstream	10 arc-sec (~300 m)	Land
Crop pollination contribution to nutrition production	Chaplin-Kramer et al. 2019 (Ref. 10), InVEST (updated)	"People fed equivalents"; average pollination-derived energy (KJ), folate, and vitamin A production divided by annual dietary requirements per capita.	10 arc-sec (~300 m)	Land
Fodder production for livestock	Mulligan et al. 2020 (Ref. 51), Co$ting Nature v3 (updated)	Index (0-1) of dry matter productivity utilized by livestock	5 arc-min (~10 km)	Land
Timber production (commercial and domestic)	Mulligan et al. 2020 (Ref. 51), Co$ting Nature v3 (updated)	Index (0-1) of accessible timber harvest for commercial & domestic use (optimized separately)	5 arc-min (~10 km)	Land
Fuel wood production	Mulligan et al. 2020 (Ref. 51), Co$ting Nature v3 (updated)	Index (0-1) of fuel wood accessible to local rural communities	5 arc-min (~10 km)	Land
Flood regulation	Gunnell et al. 2019 (Ref. 32), WaterWorld v2 (updated)	Index (0-1) of green water storage * number of people downstream.	5 arc-min (~10 km)	Land
Access to nature (local recreation and gathering)	Chaplin Kramer et al. (new for this analysis)	Count of people within 10 km of natural and semi-natural habitat	10 arc-sec (~300 m)	Land
Riverine fish catch	McIntyre et al. 2016 (Ref. 16) (updated)	Metric tonnes of fish caught per sq km per year	5 arc-min (~10 km)	Land, freshwater
Marine fish catch	Watson and Tidd 2018 (Ref. 54); (updated)	Metric tonnes of fish caught per sq km per year	30 arc-min (~55 km)	Ocean
Coral reef tourism (nature-based recreation and associated livelihoods)	Spalding et al. 2017 (Ref. 31)	Dollar expenditures (expressed in deciles 1-10)	30 arc-sec (~1 km)	Ocean
Coastal risk reduction	Chaplin-Kramer et al. 2019 (Ref. 10), InVEST (updated)	Unitless risk reduction index * number of people within protective distance	10 arc-sec (~300 m)	Land and ocean

All NCP (mapped in Extended Data Fig. 1) are "realized," either as an end use or benefit (e.g., timber or fish harvest per unit area of land or water), or, where possible given current data, weighted by number of beneficiaries. All NCP are attributed to the "natural" ecosystems providing the benefit (see Table 4), resampled to 2 km for prioritization. "Source" indicates the data source, but where indicated, datasets were updated (or newly generated) for this analysis by the authors, as detailed in the SI Methods.

Extended Data Table 2 | Global climate NCP and other supporting datasets

Data set	Source	Units	Original resolution
Climate regulation NCP (not included in national-level optimization; optimized globally)			
Ecosystem carbon storage*	Noon et al2021 (Ref. 30)	Tonnes of carbon/ha (for terrestrial ecosystems and mangroves)	1 arc-sec (~30 m)
Atmospheric moisture recycling*	Keys et al. 2016 (Ref. 21) (updated)	Fraction of evapotranspiration from vegetation that is providing precipitation to rainfed productive lands	1.5 degree
Biological diversity			
Terrestrial vertebrates Area of Habitat (AOH)*	Roerhdanz, Conservation International, (new for this analysis) Based on IUCN Red List data and methods from Brooks et al. 2019 (Ref. 22)	N/A (species Area of Habitat (AOH) polygons for 29,000 mammals, birds, amphibians, and reptiles)	N/A (vector)
Cultural diversity			
Languages*	Gorenflo et al. 2012 (Ref. 23) (updated)	N/A (indigenous and non-migrant language range polygons)	N/A (vector)
Additional input datasets			
Land cover	ESA Climate Change Initiative 2017	N/A (Masks for NCP layers included all land cover classes from ESA 2015 except for cropland, mosaic cropland, urban areas, bare areas, water bodies, permanent snow & ice)	10 arc-sec (~300 m)
Coastal habitat	ESA Climate Change Initiative 2017 (terrestrial coastal habitat), Burke et al. 2011 (Ref. 56) (coral reefs), Bunting et al. 2018 (Ref. 59) (mangroves), UNEP-WCMC & Short 2018 (Ref. 57) (seagrass), Mcowen et al. 2017 (Ref. 58) (salt marsh)	N/A (coastal habitat types)	ESA: 10 arc-sec Burke et al. 2011: N/A Bunting et al: UNEP-WCMC and Short 2018: Mcowen et al: N/A (vectors)
Dry matter productivity*	Copernicus Service Information 2019	kg/ha/day (converted to a 10-year average 2009-2018, so kg/ha)	30 arc-sec (~1 km)
Human population*	Landscan 2017, Rose et al. 2018 (Ref. 48)	Ambient or average day / night population count (people per square km)	30 arc-sec (~1 km)
Urban and rural catchment areas*	Cattaneo et al. 2021 (Ref. 52)	Urban to rural gradient classification (1 being most urban 30 being most rural)	30 arc-sec (~1 km)
Friction surface*	Weiss et al. 2018 (Ref. 14)	Minutes required to move one meter	30 arc-sec (~1 km)
Land and ocean boundaries	Flanders Marine Institute 2020 Union of ESRI country shapefile and Exclusive Economic Zones v3	N/A (polygons)	NA

*These datasets are mapped only for land.

Extended Data Table 3 | ESA Land Use/Land Cover (LULC) classes to which different terrestrial NCP were masked

ID	Description	Grazing: herbaceous only	Timber: forests only	Fuelwood: woody only	All other terrestrial NCP: all natural/semi-natural	Inland fisheries: + water
10	Cropland, rainfed					
11	Cropland, rainfed, herbaceous cover					
12	Cropland, rainfed, tree or shrub cover					
20	Cropland, irrigated or post-flooding					
30	Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover)(<50%)	X	X	X	X	X
40	Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland(<50%)	X	X	X	X	X
50	Tree cover, broadleaved, evergreen, closed to open (>15%)		X	X	X	X
60-62	Tree cover, broadleaved, deciduous, closed to open (>15%)		X	X	X	X
70-72	Tree cover, needleleaved, evergreen, closed to open (>15%)		X	X	X	X
80-82	Tree cover, needleleaved, deciduous, closed to open (>15%)		X	X	X	X
90	Tree cover, mixed leaf type (broadleaved and needleleaved)		X	X	X	X
100	Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	X	X	X	X	X
110	Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	X	X	X	X	X
120-122	Shrubland	X		X	X	X
130	Grassland	X			X	X
140	Lichens and mosses	X			X	X
150	Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	X	X	X	X	X
151	Sparse tree (<15%)	X	X	X	X	X
152	Sparse shrub (<15%)	X		X	X	X
153	Sparse herbaceous cover (<15%)	X			X	X
160	Tree cover, flooded, fresh or brackish water		X	X	X	X
170	Tree cover, flooded, saline water		X	X	X	X
180	Shrub/ herbaceous cover, flooded, fresh/saline/brackish water	X		X	X	X
190	Urban areas					
200-202	Bare areas					
210	Water bodies					X
220	Permanent snow and ice					

Extended Table 4 | Correspondence between different pairs of nature's contributions to people (NCP), based on individual optimizations for each NCP. Vulnerable carbon and moisture regulation were optimized globally; all other NCP were optimized at the country level. Columns show the percent of the area required to maintain 90% of that NCP alone, and then the % of overlap with the area required by other NCP. As different NCP require vastly different areas, overlaps between NCP pairs may matter more for one of the NCP than the other (e.g., sediment retention requires less than a third of the area of flood mitigation or nitrogen retention, so while the overlap accounts for a large percentage of the area required by sediment, it accounts for a much smaller percentage of the areas required by the other two). The highest correspondence between NCP is shown in green (darker shades highlighting the top 10% of overlap values, lighter shades highlighting the top 25%).

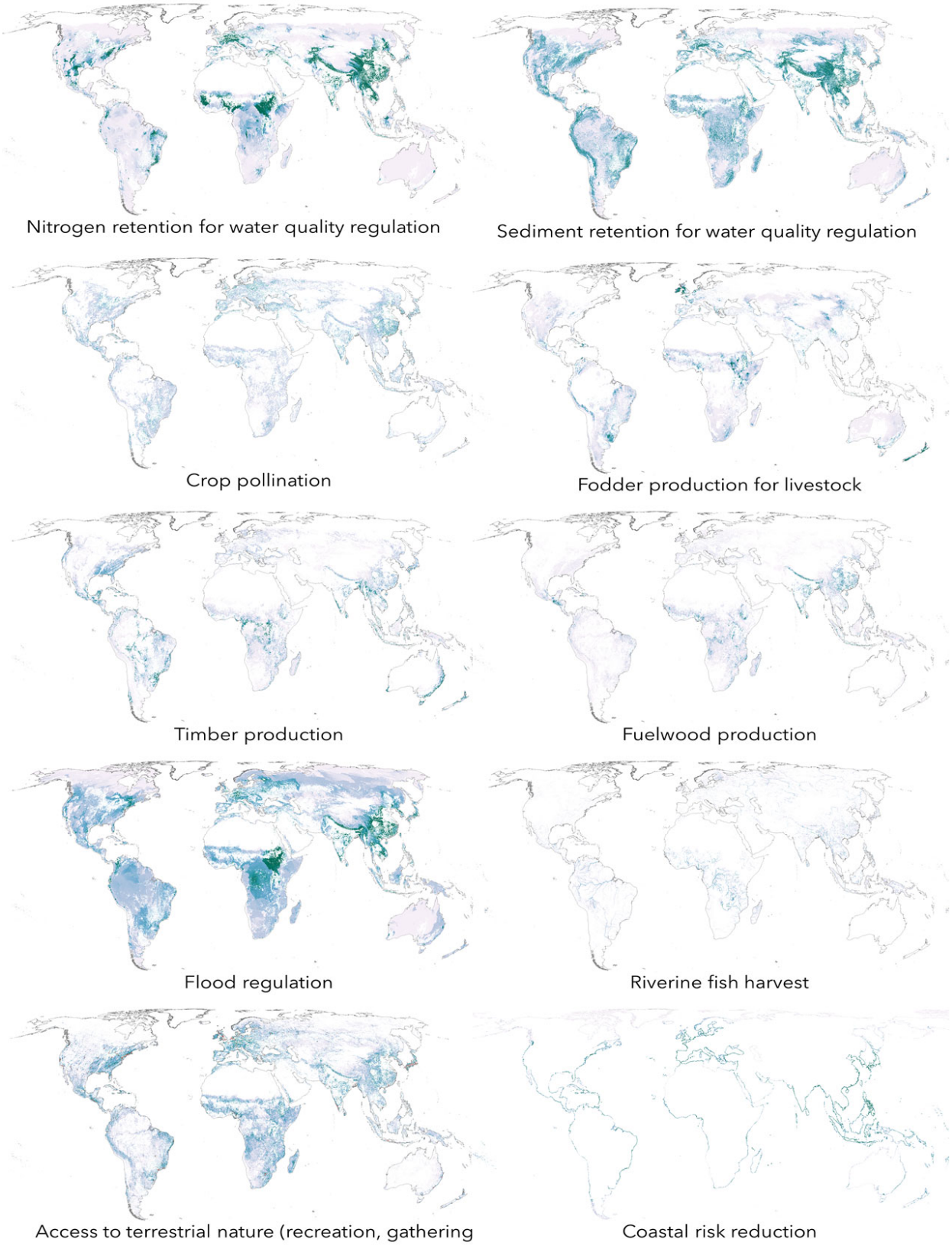
		carbon	moisture	coastal	flood	fuelwood	riverine fish	grazing	nature access	nitrogen	pollination	sediment	timber
	Total area required (million sq km)	*46.6*	*46.0*	*0.2*	*28.1*	*14.6*	*3.2*	*19.9*	*15.1*	*28.6*	*4.6*	*9.3*	*19.7*
% overlap with area required by:	carbon		71%	36%	76%	76%	72%	51%	63%	72%	60%	66%	83%
	moisture	70%		5%	79%	74%	62%	68%	70%	79%	66%	78%	73%
	coastal	0.14%	0.02%		0.02%	0.23%	0.44%	0.05%	0.41%	0.02%	0.32%	0.00%	0.15%
	flood	46%	48%	2%		64%	52%	44%	57%	70%	59%	66%	61%
	fuelwood	24%	23%	19%	33%		35%	-	55%	33%	53%	38%	59%
	riverine fish	5%	4%	8%	6%	8%		4%	9%	5%	12%	6%	6%
	grazing	22%	29%	5%	31%	-	27%		47%	36%	55%	44%	-
	nature access	21%	23%	34%	31%	57%	43%	36%		32%	63%	38%	37%
	nitrogen	44%	49%	3%	71%	64%	46%	51%	61%		65%	83%	59%
	pollination	6%	7%	8%	10%	17%	18%	13%	19%	10%		15%	10%
	sediment	13%	16%	0%	22%	24%	16%	21%	24%	27%	31%		20%
	timber	35%	31%	16%	43%	80%	39%	-	49%	41%	43%	43%	

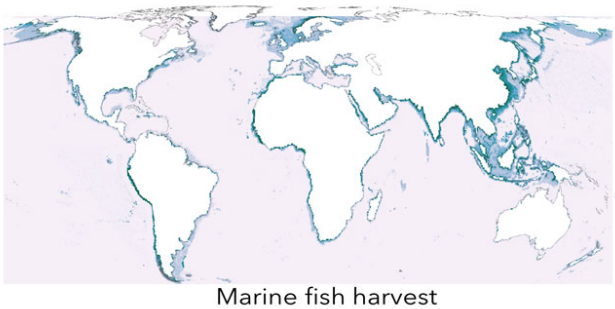
		coastal	marine fish	reef tourism
	Total area required (million sq km)	*0.10*	*33.797*	*0.15*
% overlap with area required by:	coastal		0.3%	21%
	marine fish	92%		82%
	reef tourism	32%	0.4%	

Extended Data Table 5 | Total area, land area and EEZ area required to provide 90% of current levels of NCP

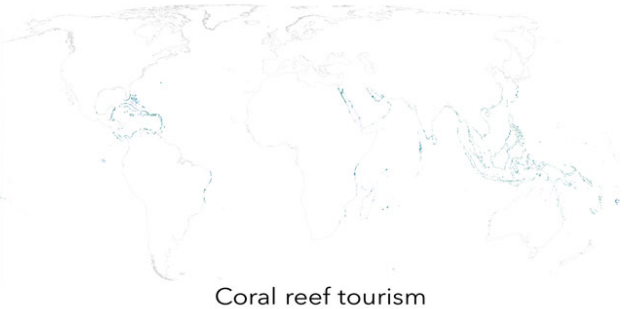
Optimization description	% Total area	% Land	% EEZ
1. Local Critical Natural Assets (LCNA): Local NCP (12 NCP without global climate NCP) together, optimized by country	27.3%	30.4%	24.2%
2. Global Critical Natural Assets (GCNA): Global climate NCP (carbon and moisture), optimized globally	18.9%	38.5%	0.0%
3. Total area of local NCP optimized by country + global NCP optimized globally (LCNA + GCNA)	34.1%	44.3%	24.2%
Sensitivity to scale			
4. Local NCP, optimized globally	17.6%	22.5%	12.9%
5. All NCP (the 12 + carbon + moisture), optimized globally	26.0%	39.5%	12.9%
6. Local NCP (as in Row 1) but with alternate nature access (longer travel time)	27.6%	31.0%	24.2%
7. Local NCP (as in Row 1) but with alternate hydro NCP (shorter attenuation)	25.1%	26.1%	24.2%
Sensitivity to NCP: 11 local NCP optimized by country, as in Row 1, but dropping 1 NCP			
8. Drop coastal risk reduction	27.2%	30.4%	24.2%
9. Drop timber production	26.8%	29.4%	24.2%
10. Drop flood mitigation	26.7%	29.2%	24.2%
11. Drop fuelwood	27.3%	30.4%	24.2%
12. Drop riverine fish	27.2%	30.3%	24.2%
13. Drop grazing	25.7%	27.1%	24.2%
14. Drop marine fish production	15.0%	30.3%	0.2%
15. Drop nature access (within 1 hour travel)	27.2%	30.2%	24.2%
16. Drop nitrogen retention	26.8%	29.5%	24.2%
17. Drop pollination	27.2%	30.4%	24.2%
18. Drop reef tourism	27.3%	30.4%	24.2%
19. Drop sediment retention	27.2%	30.4%	24.2%
Individual NCP optimized by country (Rows 20-32) or globally (Rows 33-34):			
20. Only coastal risk reduction	0.1%	0.1%	0.1%
21. Only timber production	7.2%	14.7%	0.0%
22. Only flood mitigation	10.3%	20.9%	0.0%
23. Only fuelwood	5.3%	10.8%	0.0%
24. Only riverine fish	1.2%	2.3%	0.0%
25. Only grazing	7.2%	14.7%	0.0%
26. Only marine fish production	12.4%	0.2%	24.2%
27. Only nature access within 1 hour travel (vs. within 6 hours)	5.5% (9.3%)	11.2% (18.8%)	0.0%
28. Only nitrogen retention with 500 km flow attenuation (vs. with 50 km)	10.4% (7.3%)	21.2% (14.9%)	0.0%
30. Only pollination	1.7%	3.4%	0.0%
31. Only reef tourism	0.1%	0.0%	0.1%
32. Only sediment retention with 500 km flow attenuation (vs. with 50 km)	3.4% (2.4%)	6.9% (4.9%)	0.0%
33. Only carbon	17.0%	34.5%	0.1%
34. Only moisture regulation	16.8%	34.1%	0.0%

Extended Data Figure 1 | Individual maps for the 14 of Nature's Contributions to People (NCP) included in critical natural assets

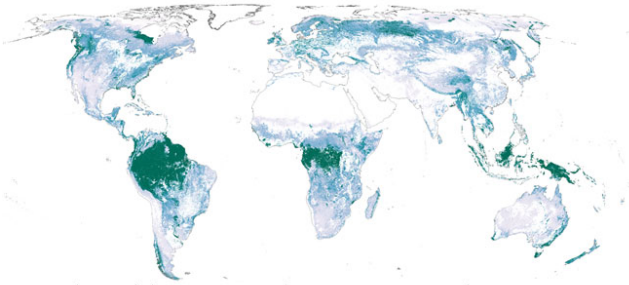




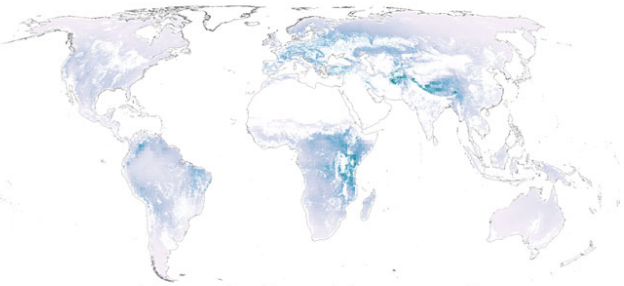
Marine fish harvest



Coral reef tourism



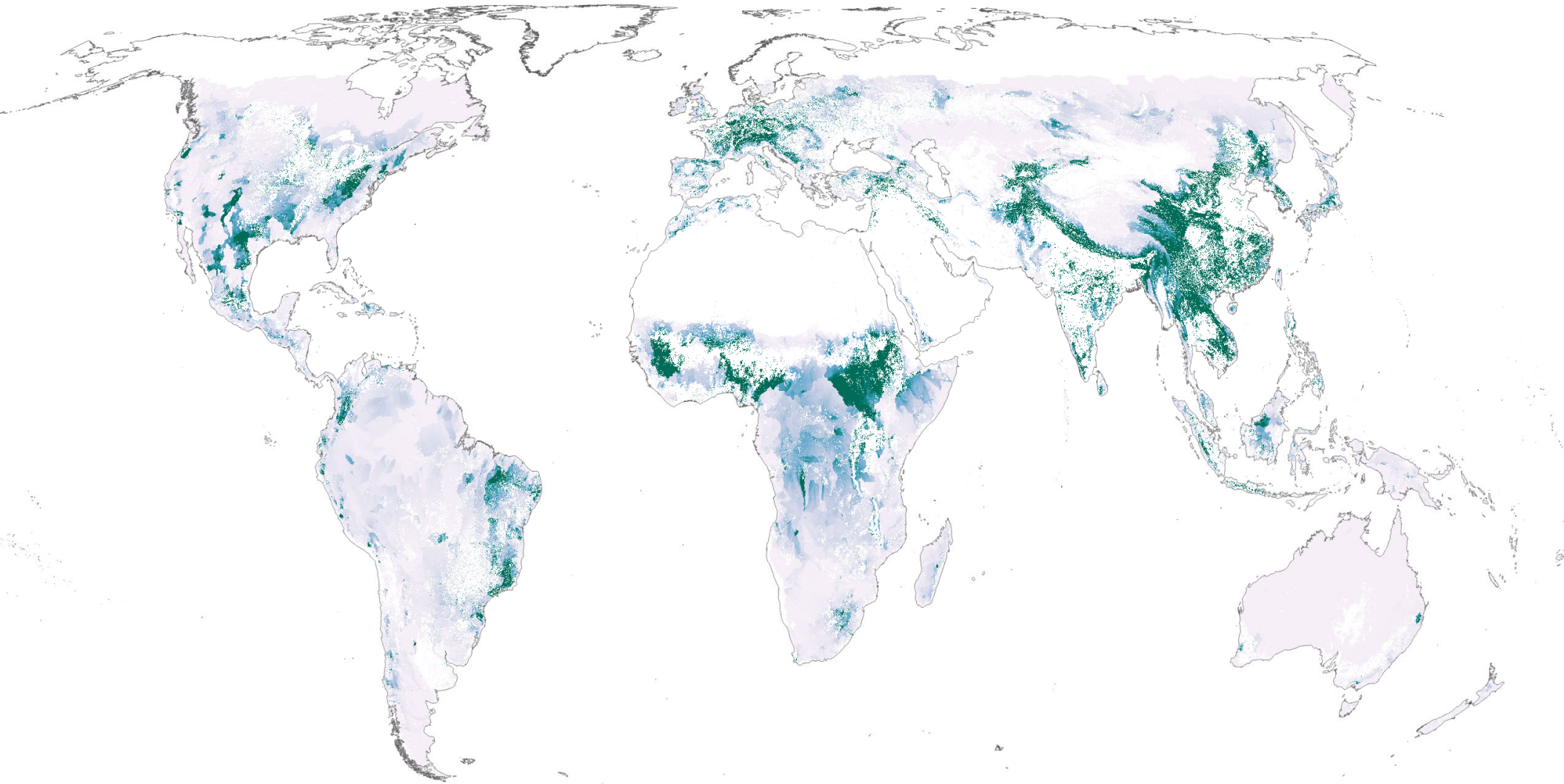
Vulnerable terrestrial ecosystem carbon storage



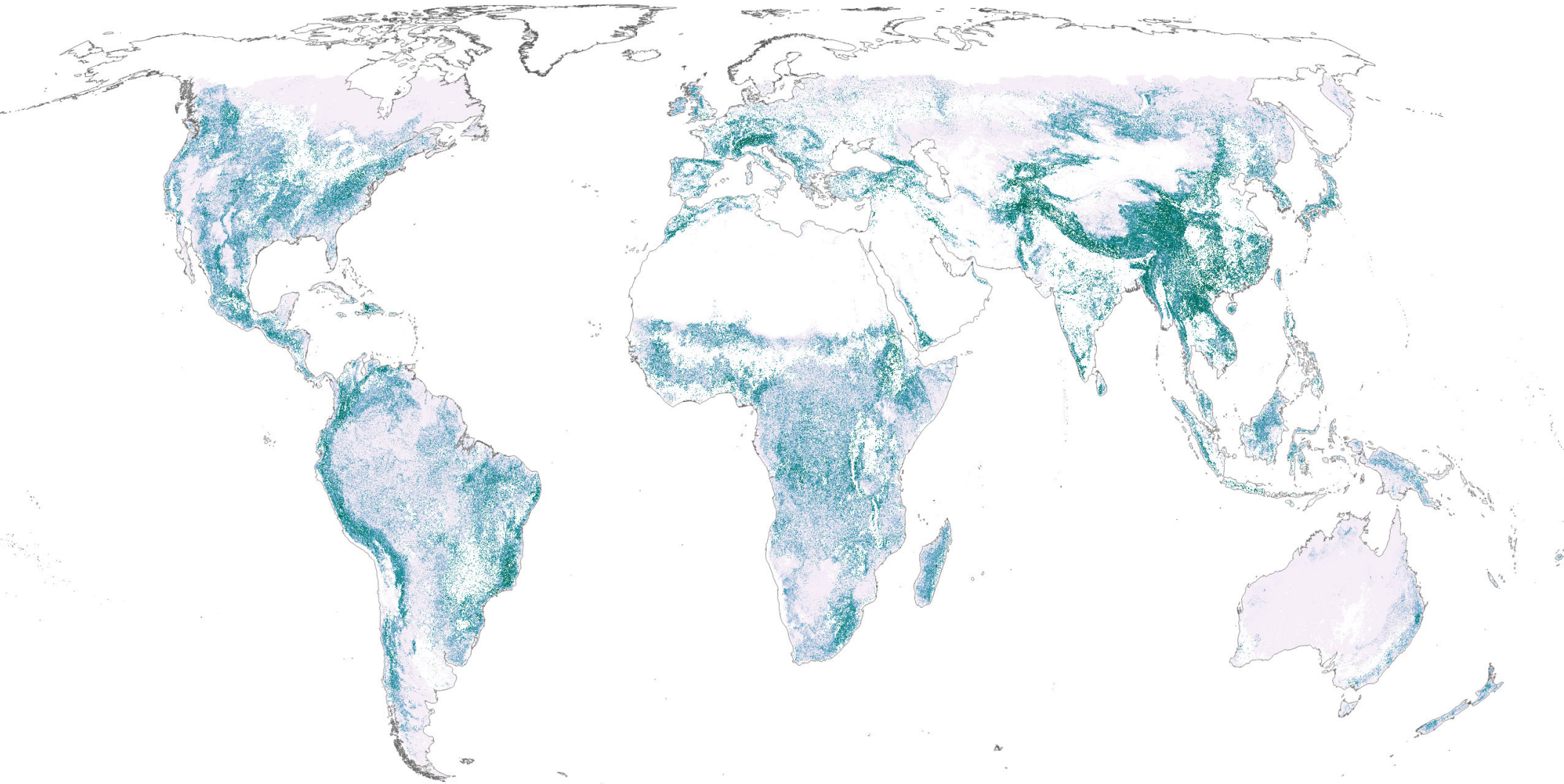
Atmospheric moisture recycling

Magnitude of NCP

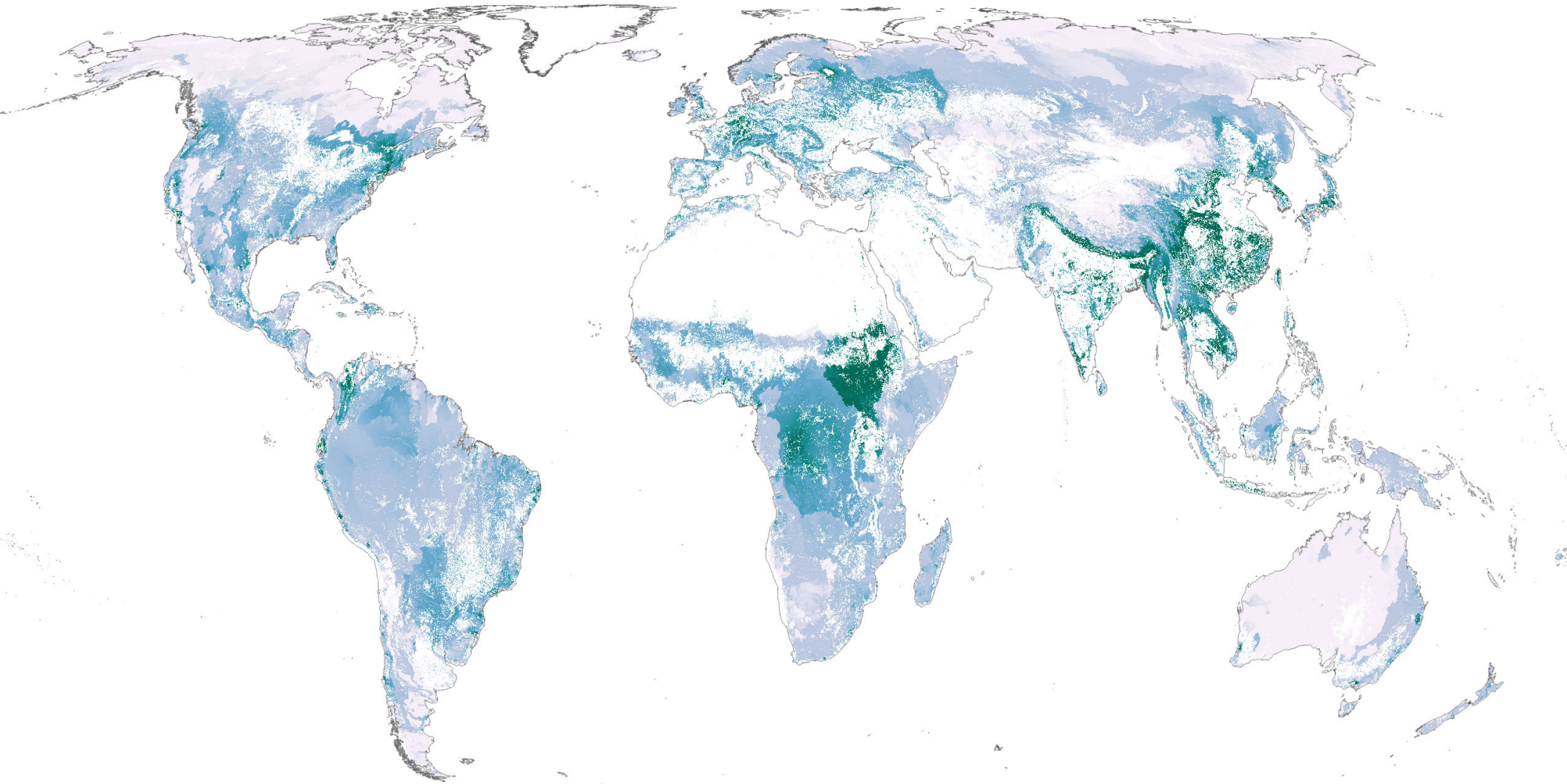
Min Max



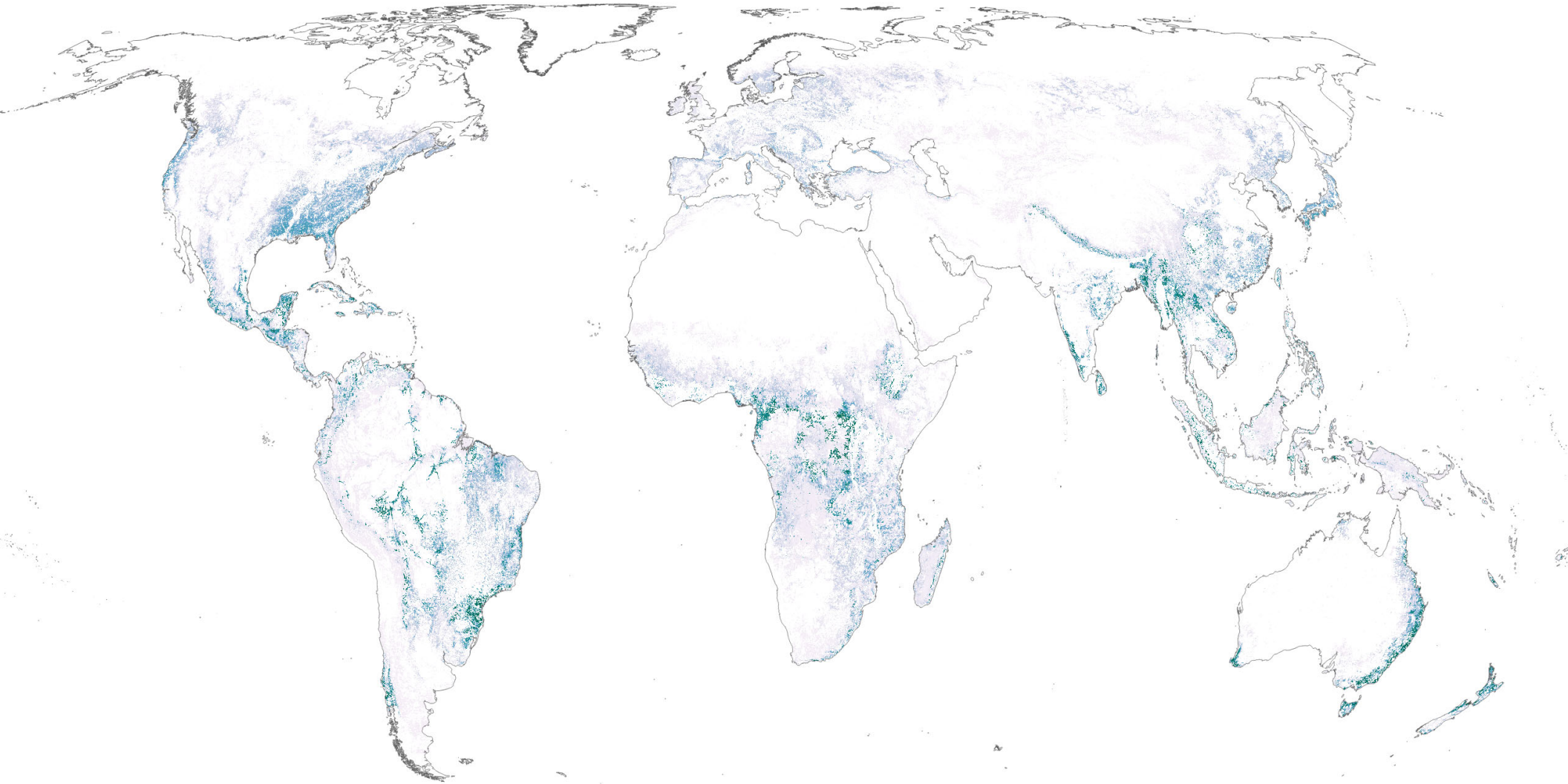
Nitrogen retention for water quality regulation



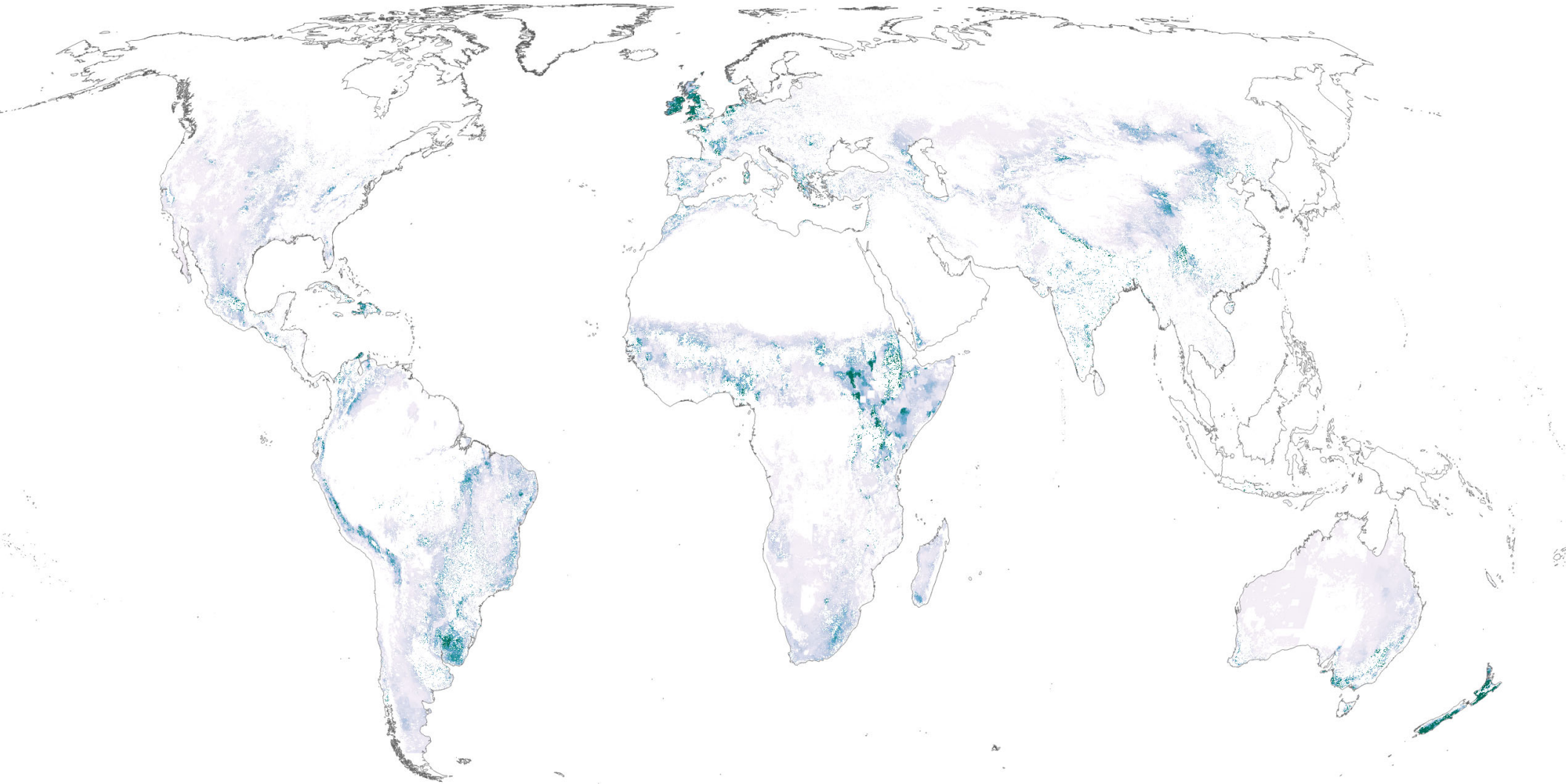
Sediment retention for water quality regulation



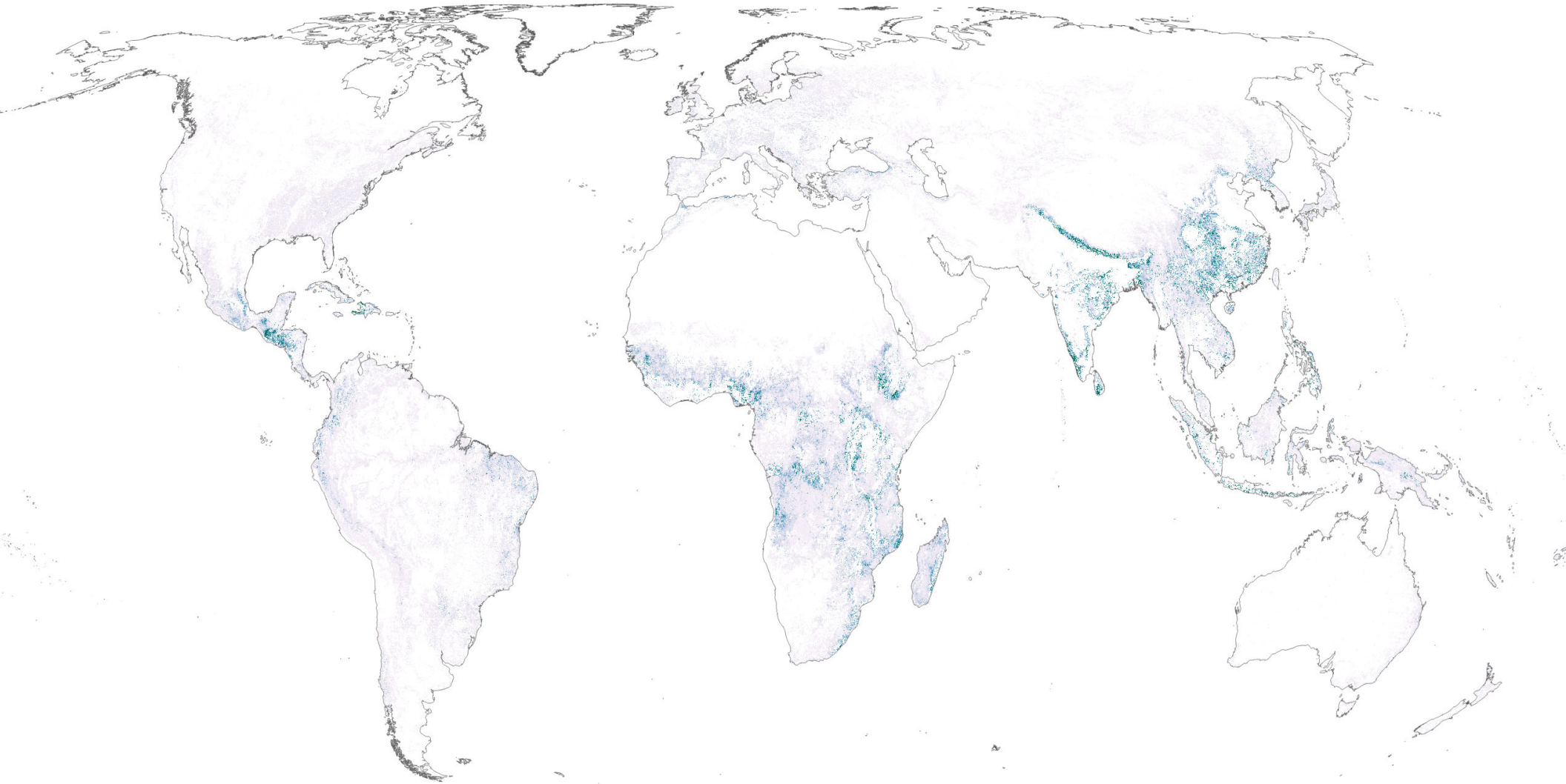
Flood regulation



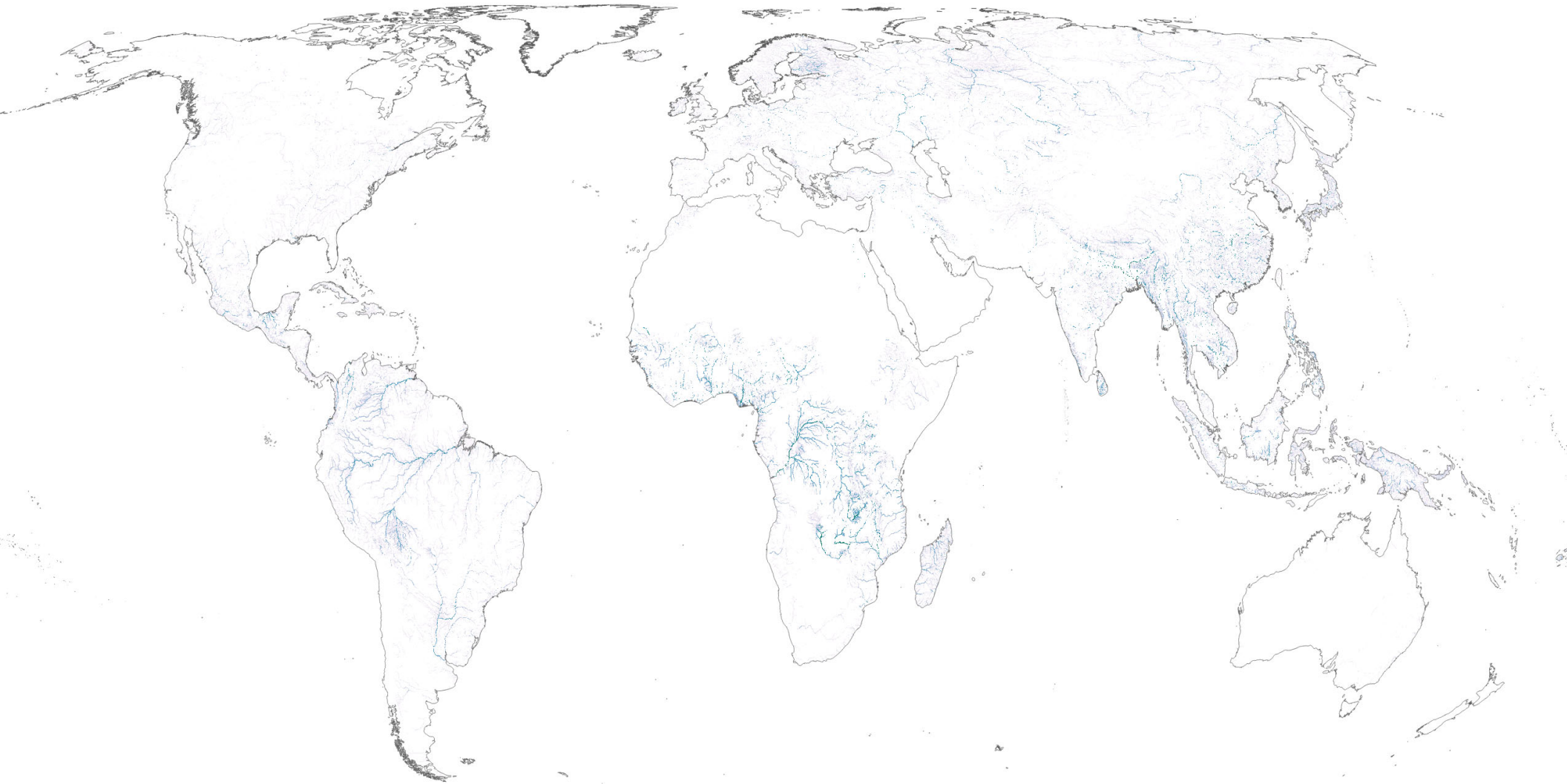
Timber production



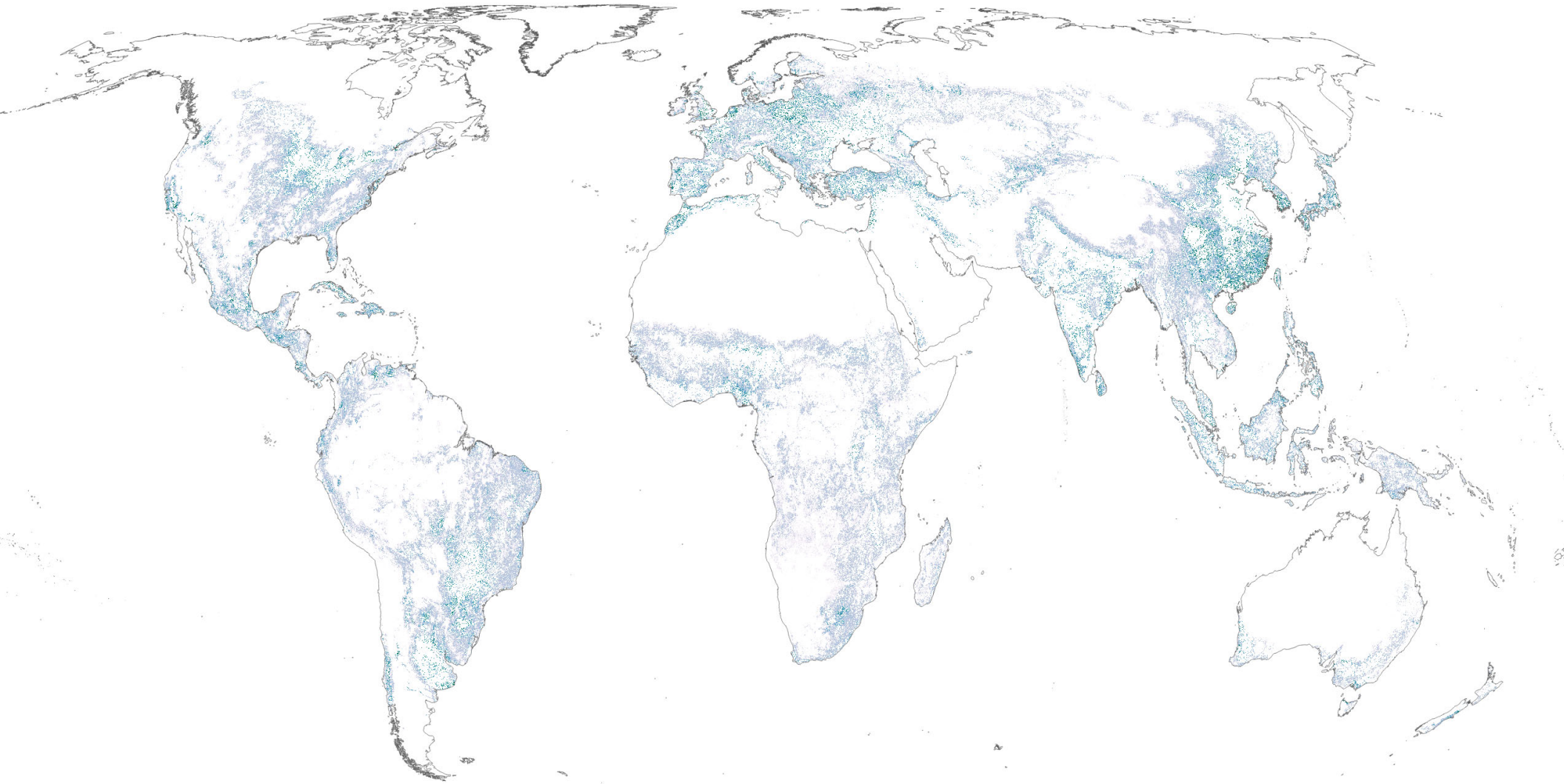
Fodder production for livestock



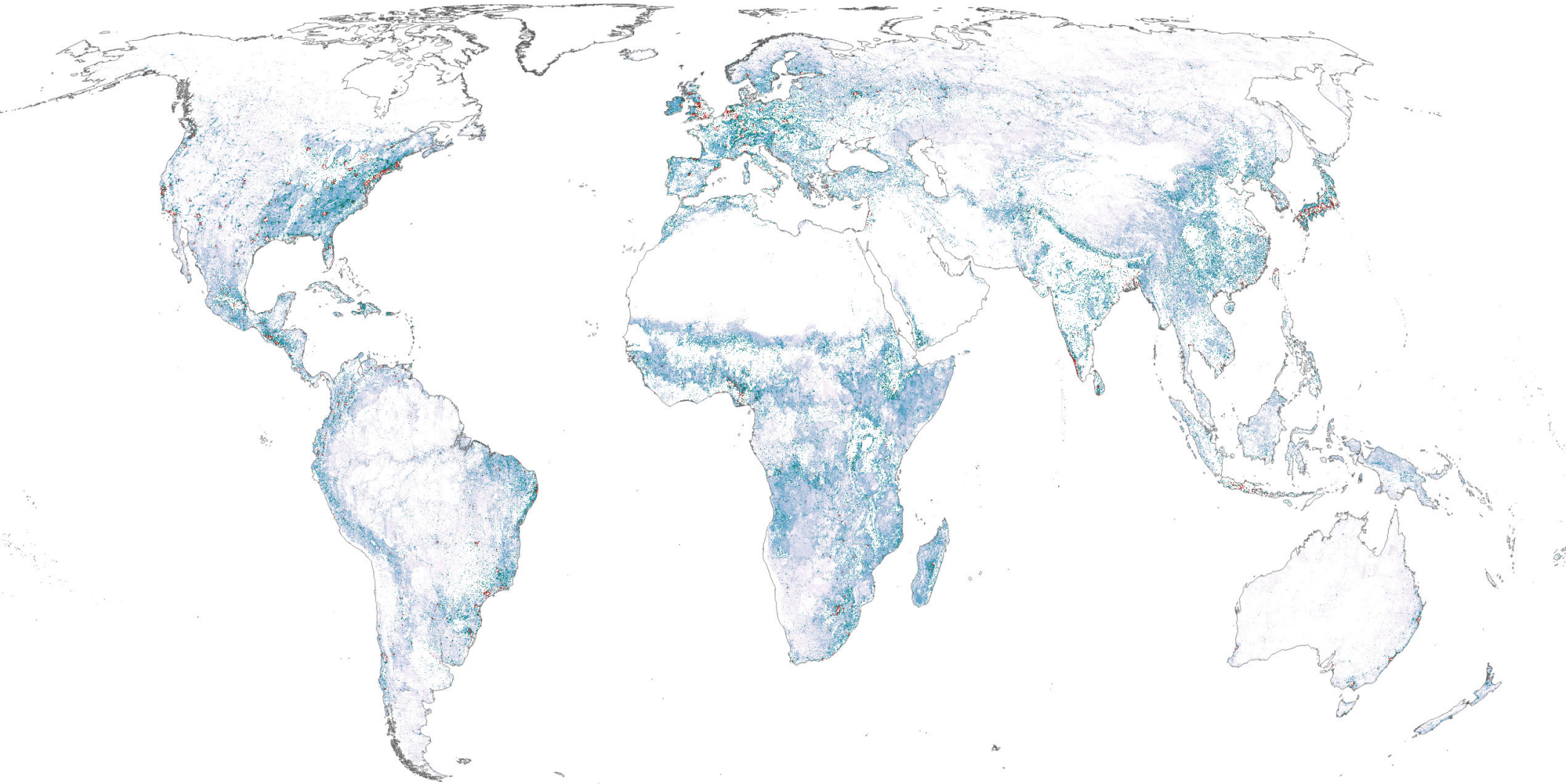
Fuelwood production



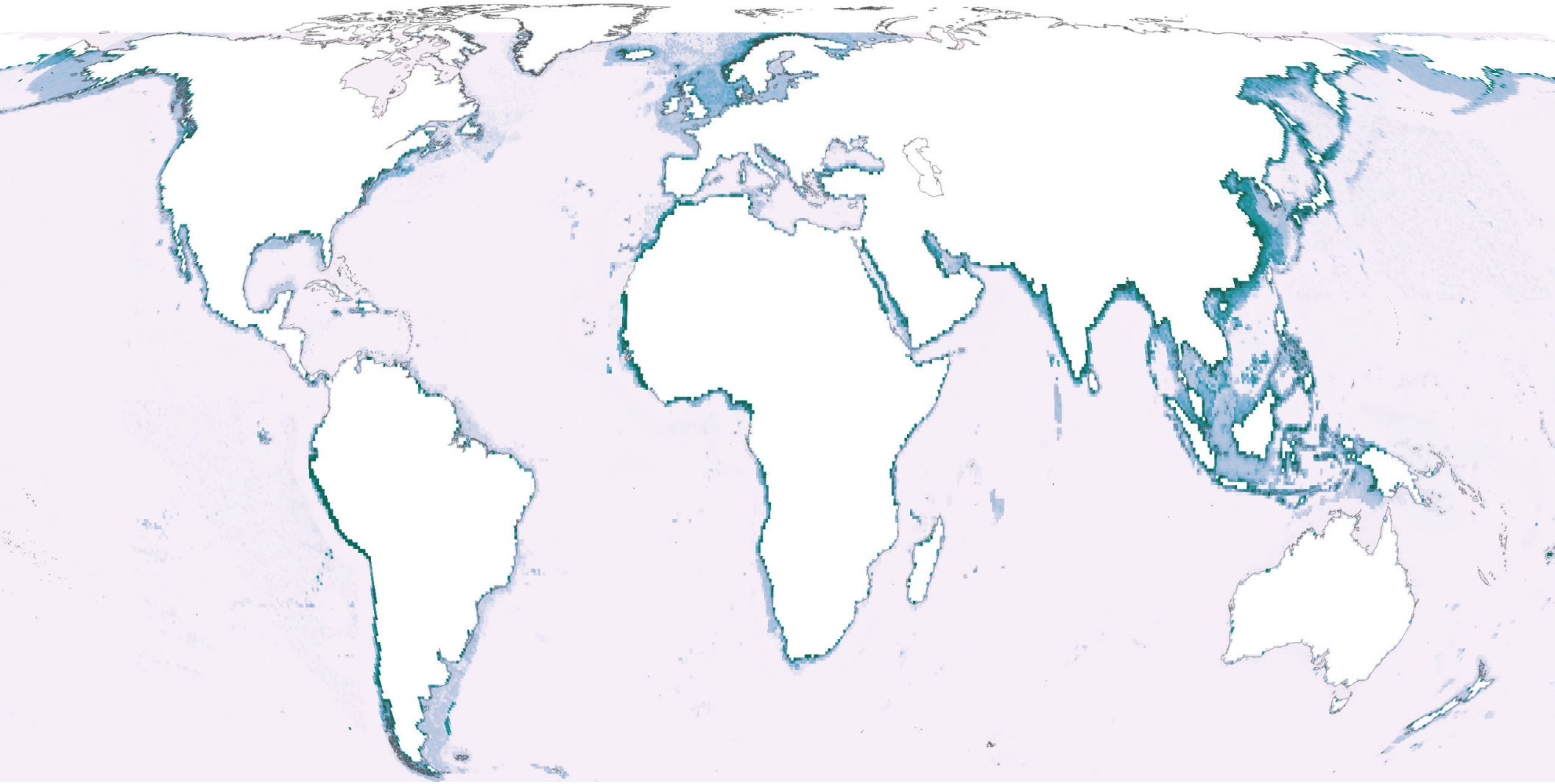
Riverine fish harvest



Crop pollination

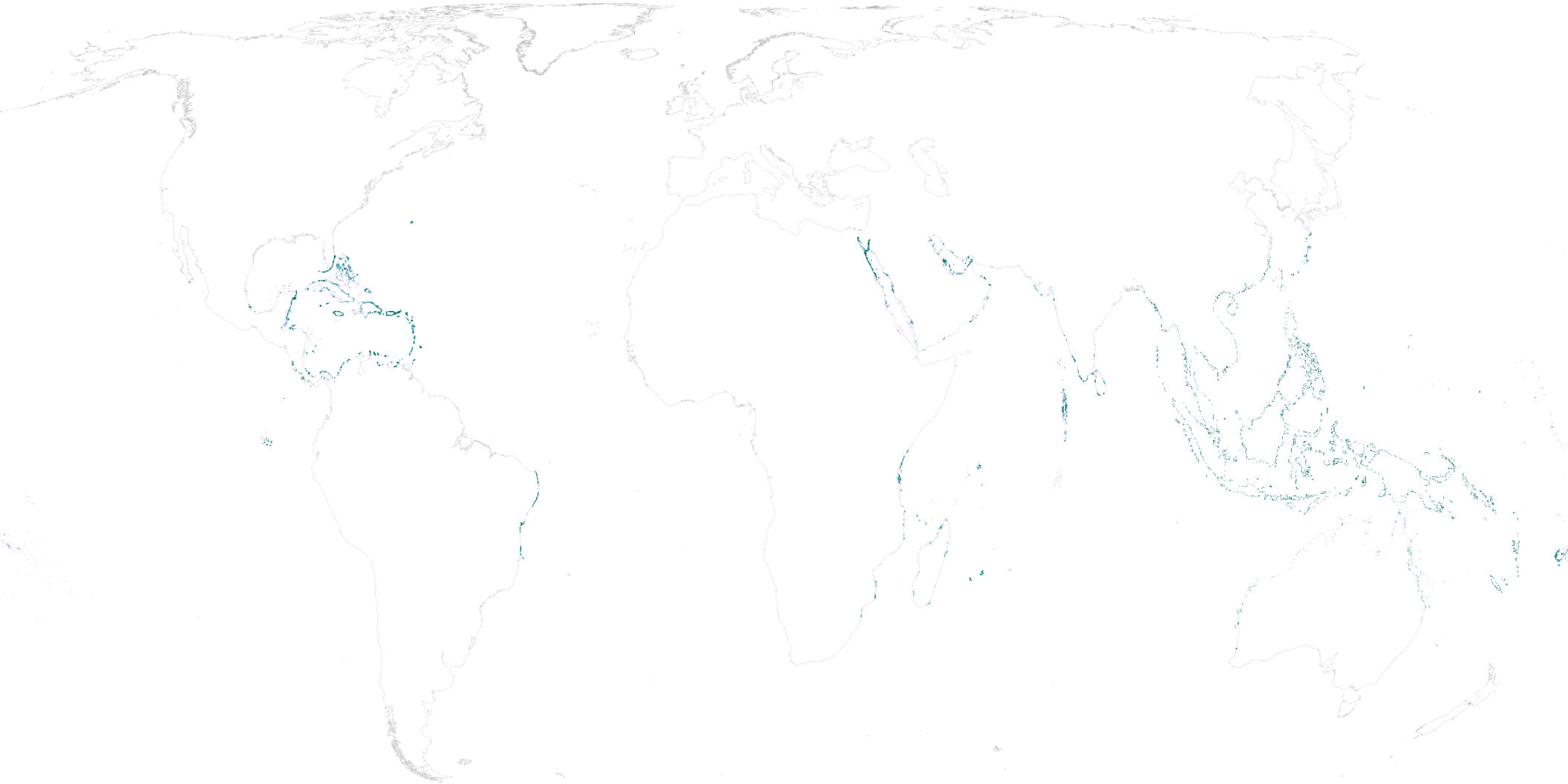


Access to terrestrial nature (recreation, gathering)

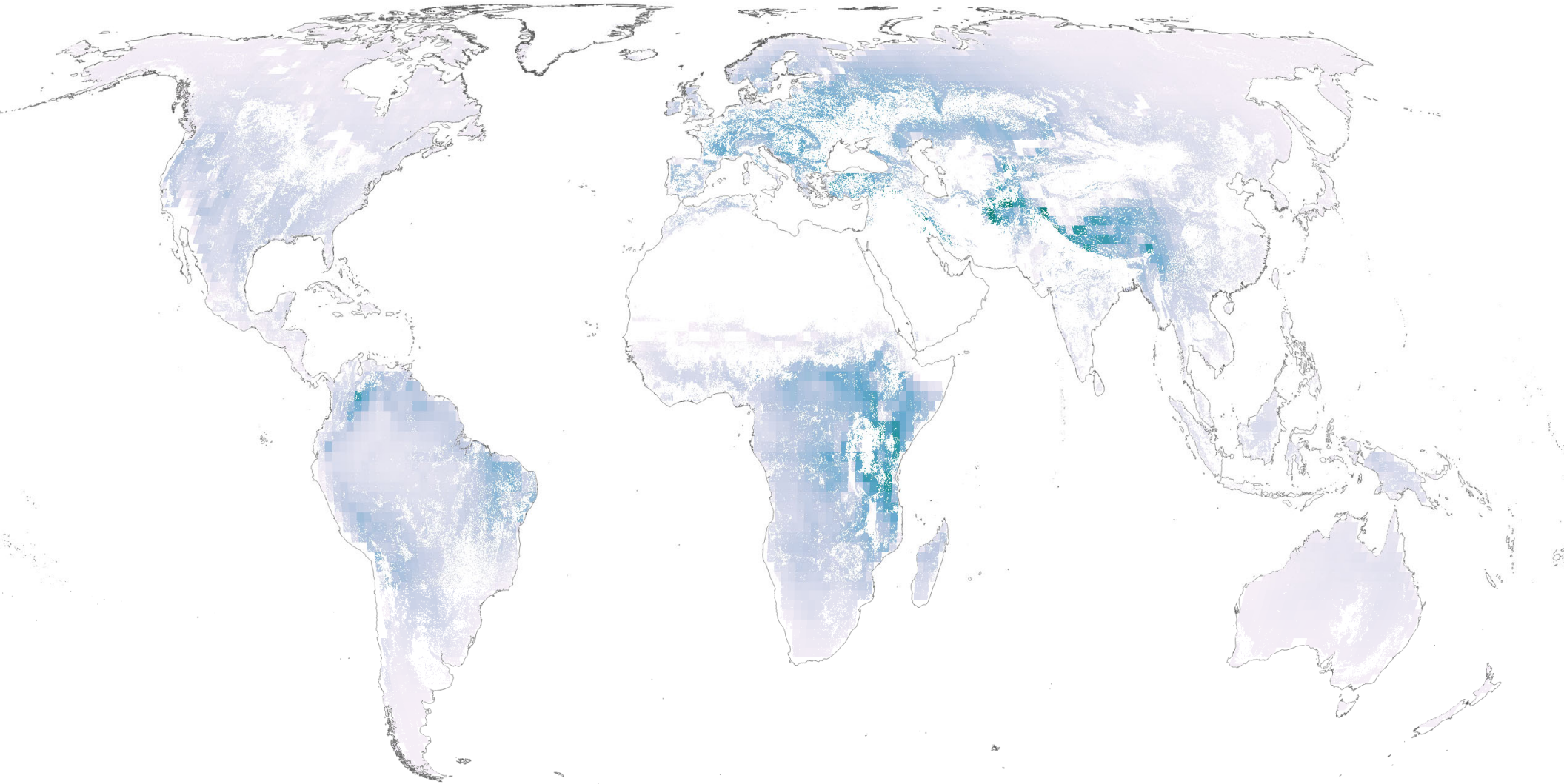


Marine fish harvest

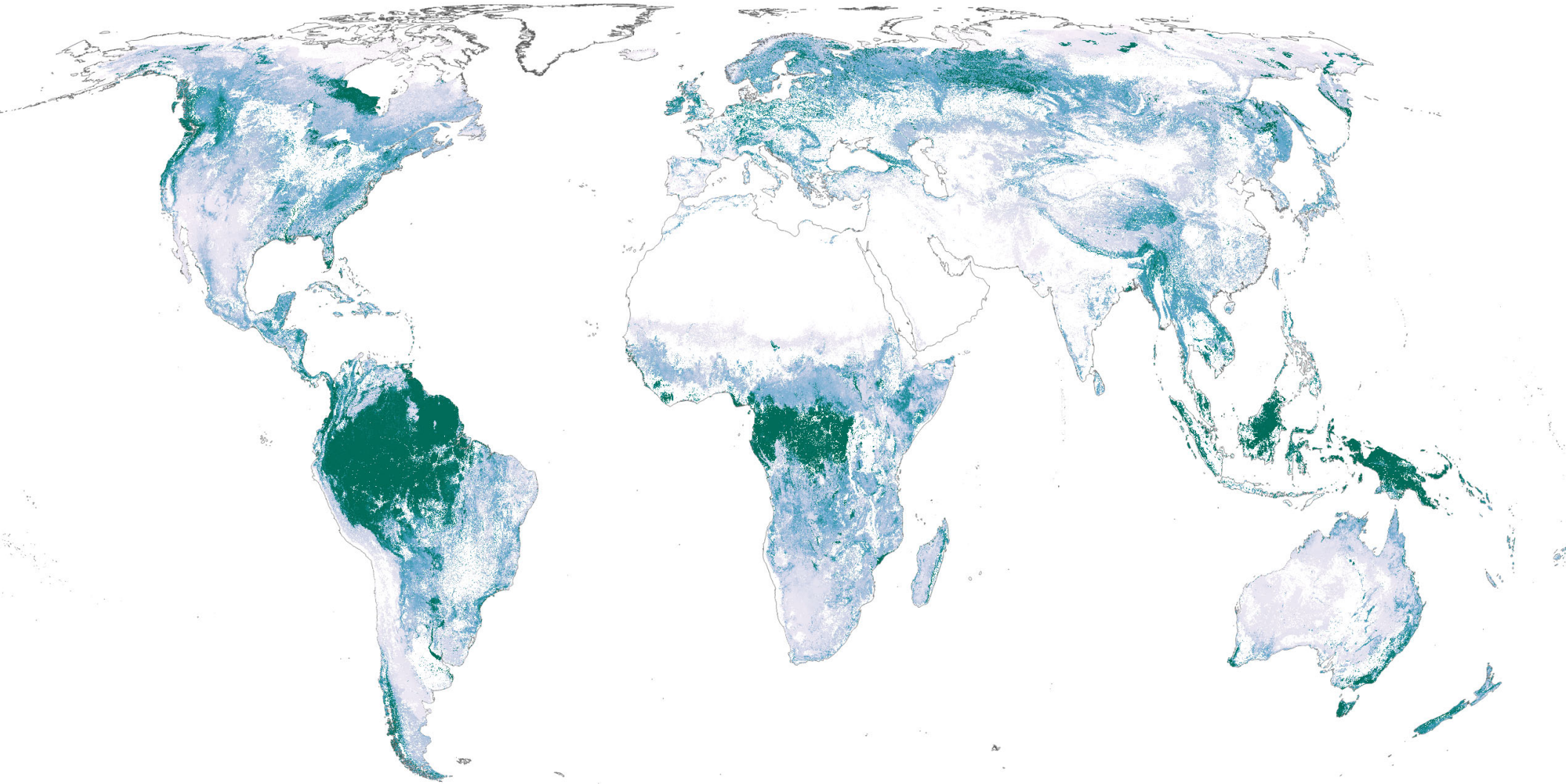
Coastal risk reduction



Coral reef tourism

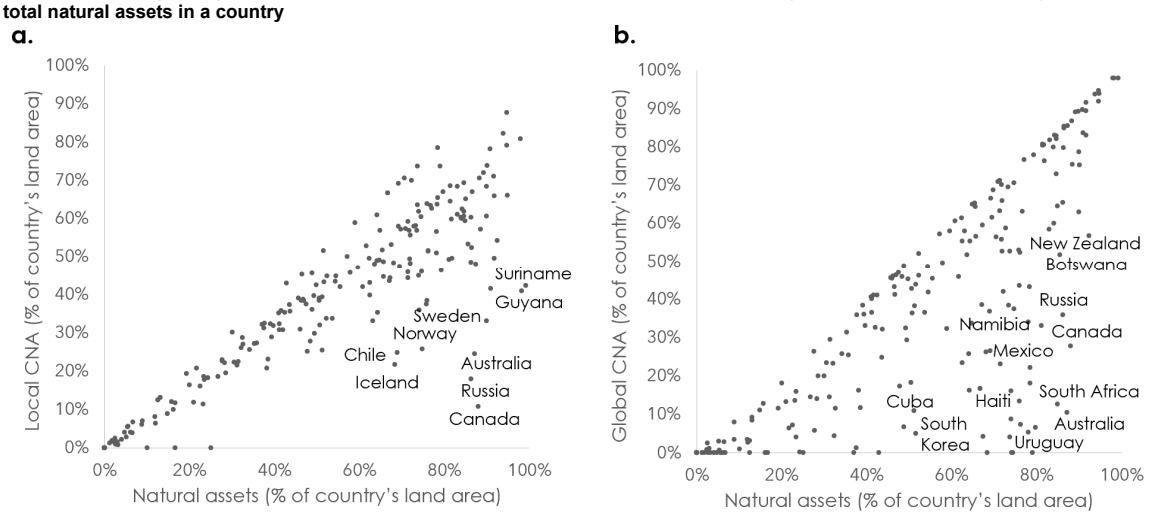


Atmospheric moisture recycling

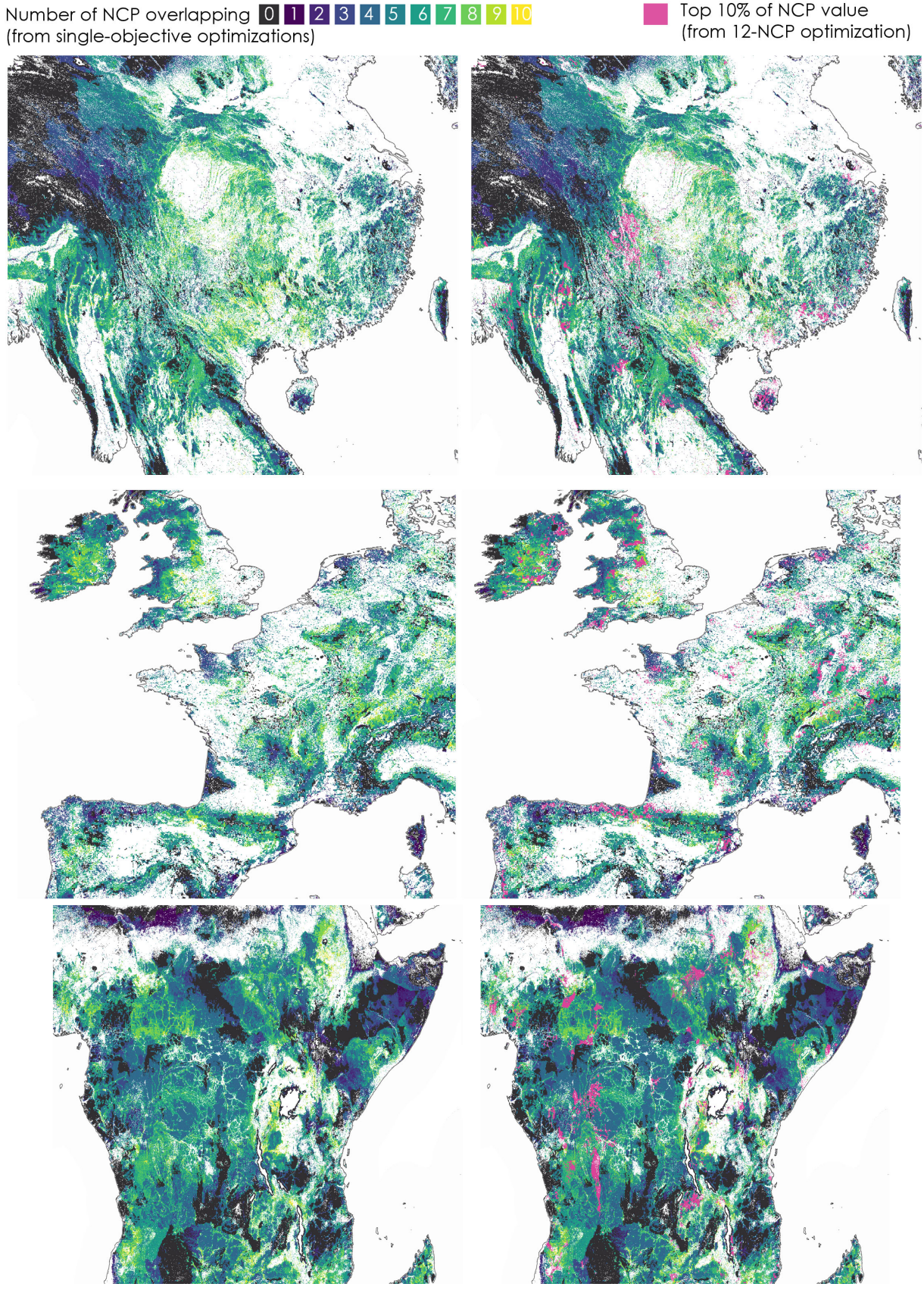


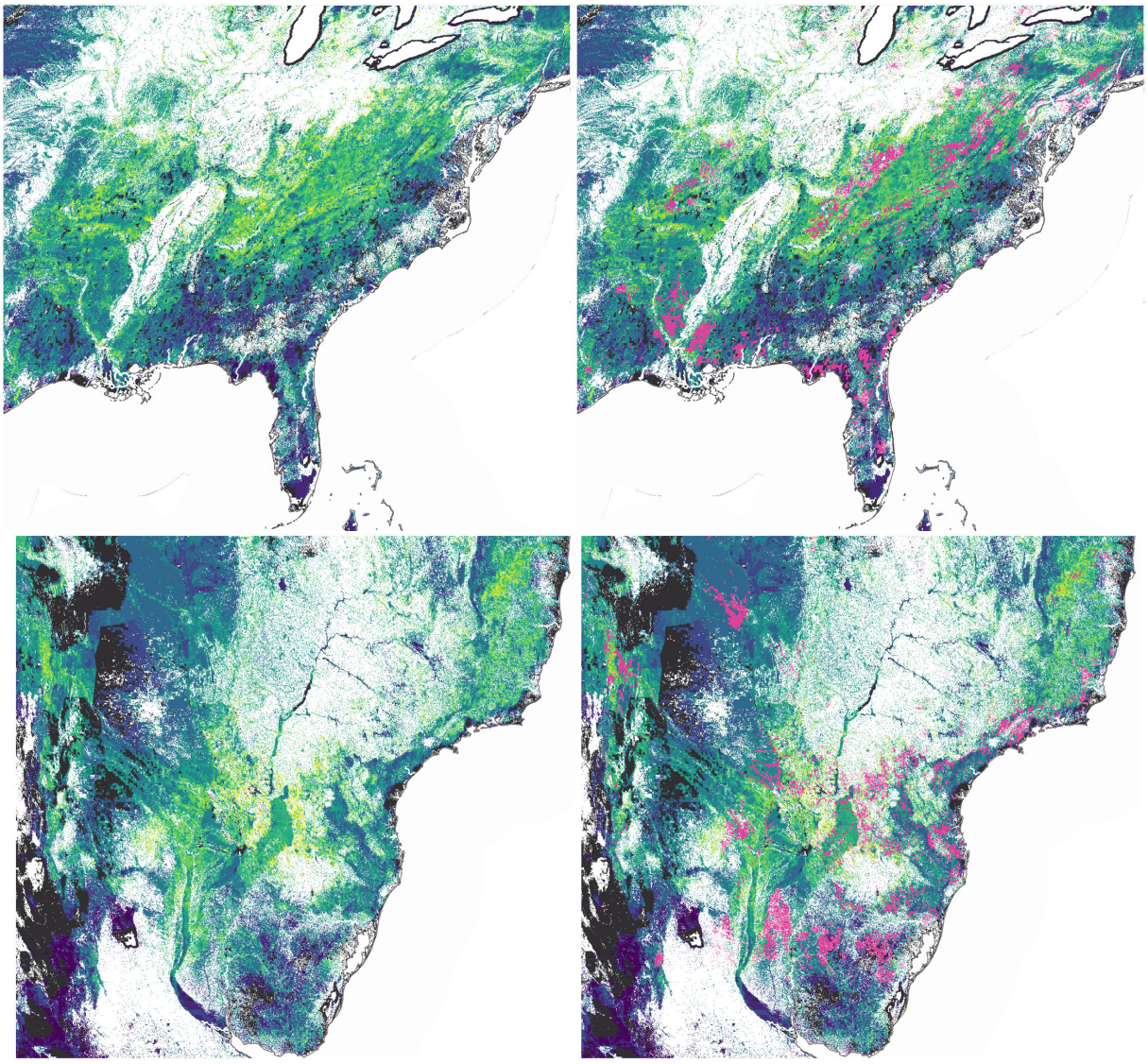
Vulnerable terrestrial ecosystem carbon storage

Extended Data Figure 2 | Percent of land in critical natural assets (CNA) for local (a) and global (b) benefits, plotted against the percentage of total natural assets in a country



Extended Data Figure 3 | Spatial congruence between NCP aligning with critical natural asset hotspots.

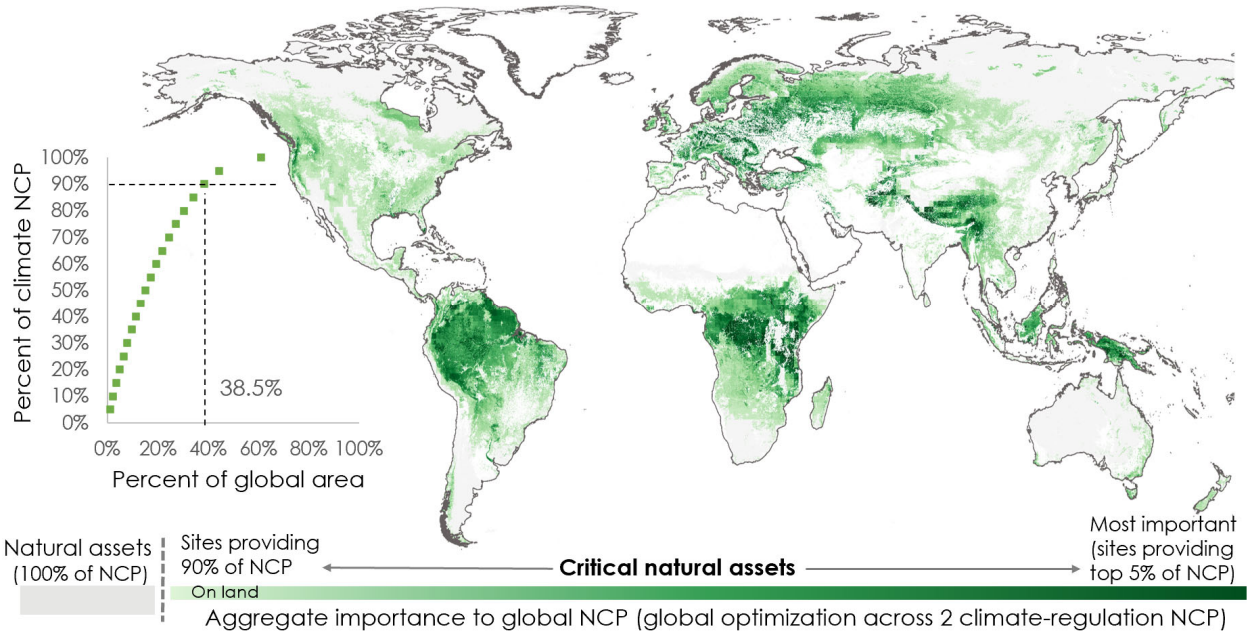




Number of NCP overlapping 0 1 2 3 4 5 6 7 8 9 10
(from single-objective optimizations)

Top 10% of NCP value
(from 12-NCP optimization)

Extended Data Figure 4 | Critical natural assets identified through optimization at the global level of two climate-relevant NCP: vulnerable carbon and vegetation-mediated atmospheric moisture regulation. As in Fig. 1, the NCP accumulation curve reflects the total area required to maintain target levels of both NCP (but in this case globally, not within each country), with dotted lines denoting the area of critical natural assets (90% of global climate NCP in 39% of land area). The map shows critical natural assets for global climate NCP, with darker shades connoting greater contribution to aggregate NCP.



Extended Data Figure 5 | Critical natural assets identified through optimization at the global level of 12 "local" NCP. As in Fig. 1, the NCP accumulation curve reflects the total area required to maintain target levels of both NCP (but in this case globally, not within each country), with dotted lines denoting the area of critical natural assets (90% of the 12 NCP listed in Fig. 1a in 22% of land area and 13% of EEZ areas). The map shows critical natural assets for global climate NCP, with darker shades connoting greater contribution to aggregate NCP.