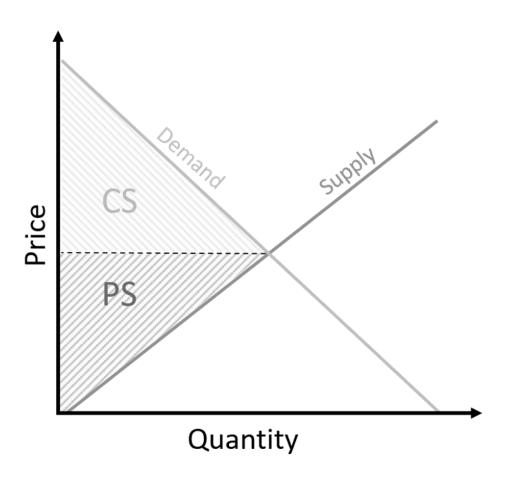
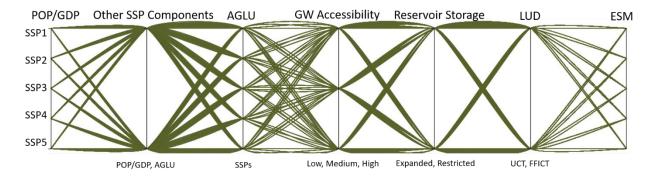
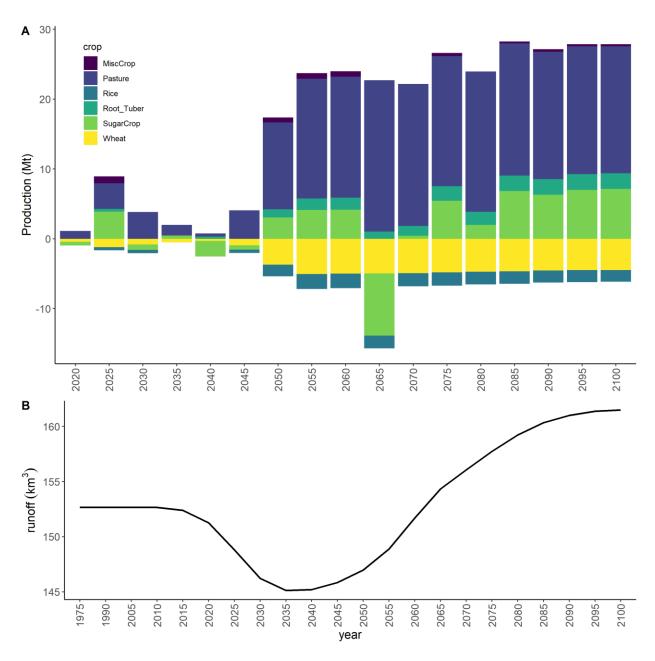
Supplementary Information



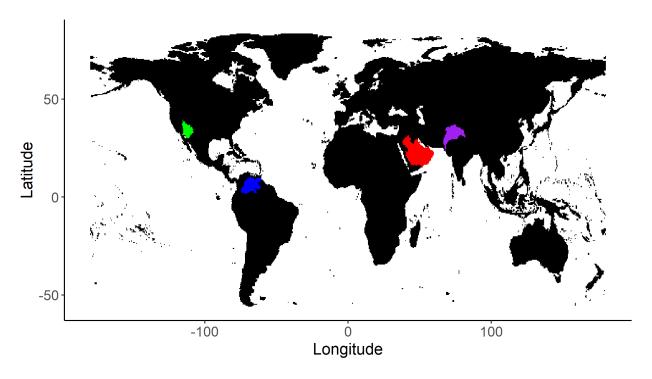
Supplementary Figure 1 Economic surplus: Consumer surplus (CS) and producer surplus (PS) are differentiated by the equilibrium price of a good (the price at which supply intersects with demand). The sum of these areas is the total surplus and has units of dollars.



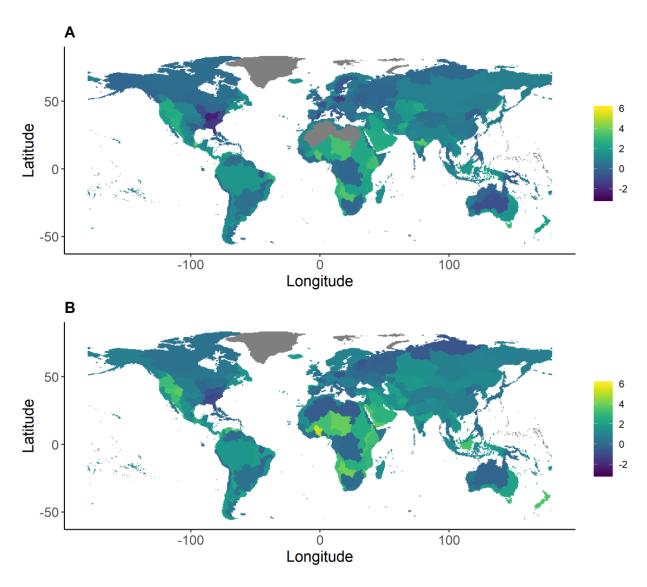
Supplementary Figure 2 Experimental design: The factorial sampling of the experimental design.



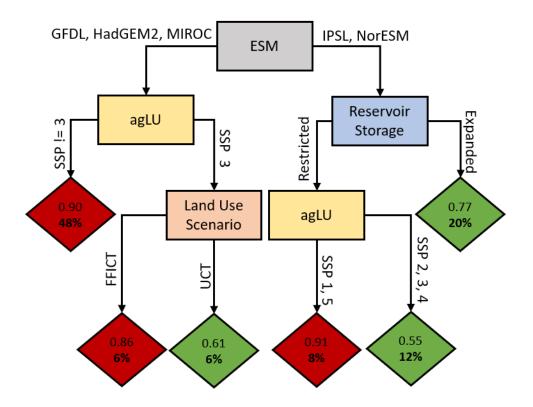
Supplementary Figure 3 Agricultural production-runoff relationship: The difference in agricultural production between the constrained water scenario and the unlimited water scenario. A) This scenario pair has SSP 5 socioeconomics, SSP 4 agriculture, SSP 4 assumptions in the other dimensions and the UCT. The constrained scenario has low groundwater availability, expanded reservoir storage and is forced with NorESM. This scenario has the highest positive impact over time in the ensemble in the Indus Basin. Increases in pasture are due to increased dairy production. The runoff is plotted in B).



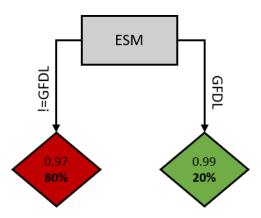
Supplementary Figure 4 Location of highlighted basins: The basins highlighted in this study. The Lower Colorado River Basin (green), the Orinoco Basin (blue), the Arabian Peninsula (red), and the Indus Basin (purple).



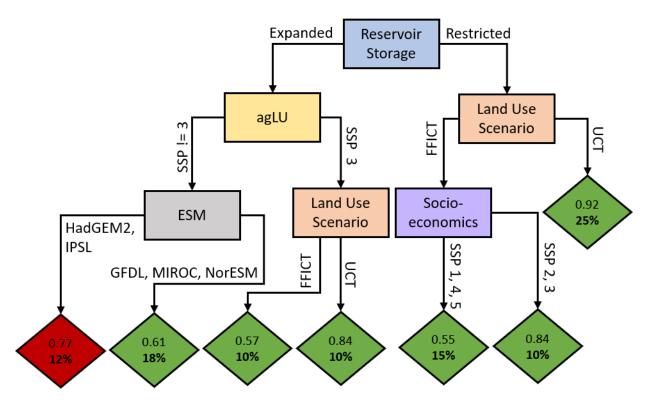
Supplementary Figure 5 Climate uncertainty amplification ratios: Log transforms of the maximum climate uncertainty amplification ratios in each basin in a single scenario with SSP 1 (A) and SSP 5 (B) demand assumptions and low water supply assumptions. Higher amplification ratios arise in higher demand scenarios.



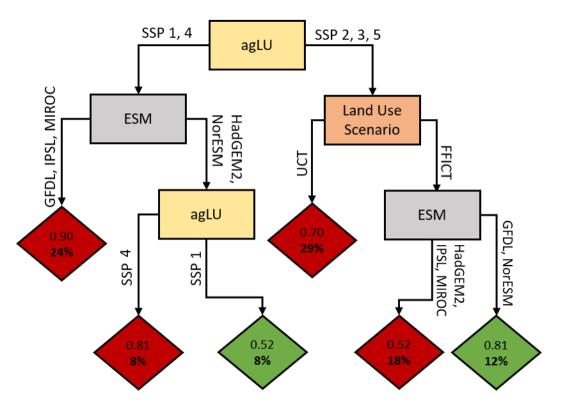
Supplementary Figure 6 Arabian Peninsula classification tree of sign of economic impact: CART classification of positive versus negative economic impact summed over time in the Arabian Peninsula. Red end nodes represent negative impact subgroups and green end nodes represent positive impact subgroups. The fraction at the top of each node shows the purity of each node. For instance, a red node with 0.91 shows that 91% of scenarios in that subgroup are negative. The percentage in each end node is the percent of scenarios out of the total within that subgroup. Earth System Model forcing is the most influential factor in determining if impact is positive or negative.



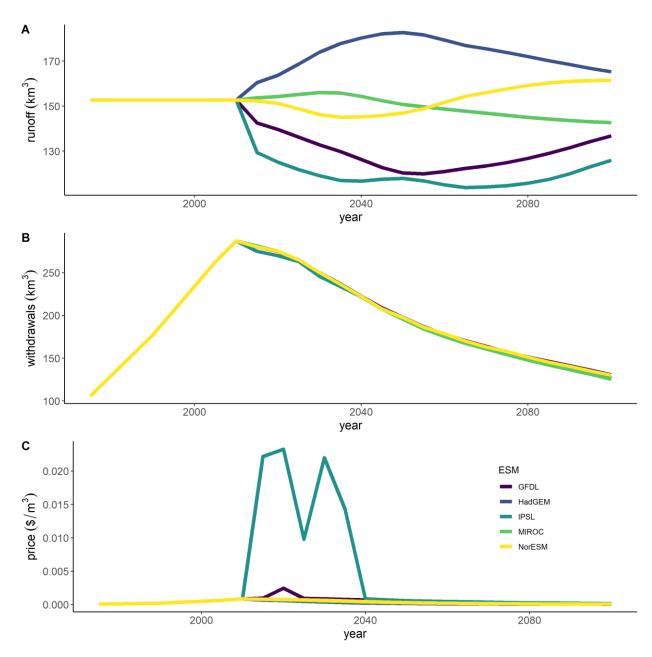
Supplementary Figure 7 Lower Colorado River classification tree of sign of economic impact: CART classification of positive versus negative economic impact summed over time in the Lower CO River Basin. Red end nodes represent negative impact subgroups and green end nodes represent positive impact subgroups. The fraction at the top of each node shows the purity of each node. For instance, a red node with 0.97 shows that 97% of scenarios in that subgroup are negative. The percentage in each end node is the percent of scenarios out of the total within that subgroup. Earth System Model forcing is the most influential factor in determining if impact is positive or negative.



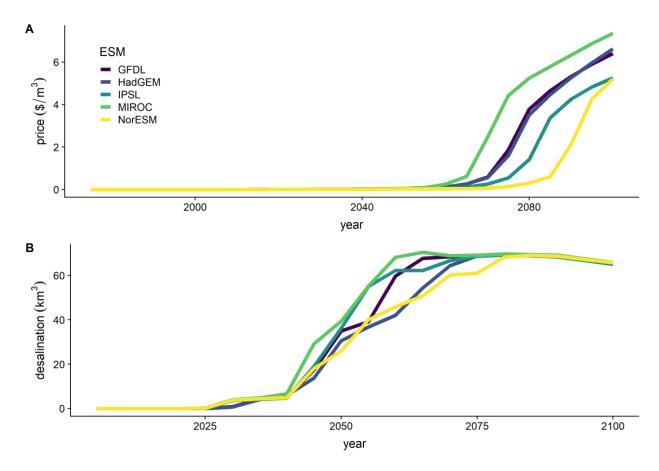
Supplementary Figure 8 Orinoco classification tree of sign of economic impact: CART classification of positive versus negative economic impact summed over time in the Orinoco Basin. Red end nodes represent negative impact subgroups and green end nodes represent positive impact subgroups. The fraction at the top of each node shows the purity of each node. For instance, a red node with 0.77 shows that 77% of scenarios in that subgroup are negative. The percentage in each end node is the percent of scenarios out of the total within that subgroup. Earth System Model forcing is one of the most influential factor in determining if impact is positive or negative.



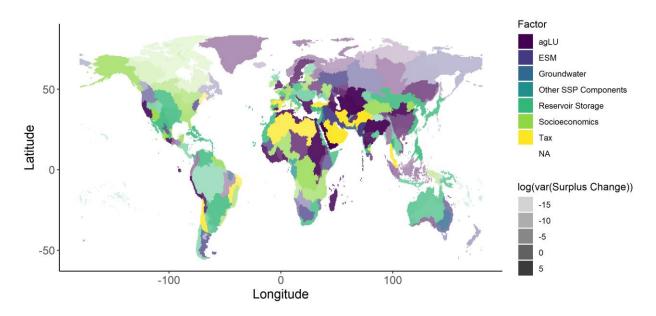
Supplementary Figure 9 Indus classification tree of sign of economic impact: CART classification of positive versus negative economic impact summed over time in the Indus Basin. Red end nodes represent negative impact subgroups and green end nodes represent positive impact subgroups. The fraction at the top of each node shows the purity of each node. For instance, a red node with 0.81 shows that 81% of scenarios in that subgroup are negative. The percentage in each end node is the percent of scenarios out of the total within that subgroup. Earth System Model forcing is one of the most influential factor in determining if impact is positive or negative.



Supplementary Figure 10 Runoff-water price relationship: Runoff A), withdrawals B), and water price C) plotted for each ESM in the Indus Basin. The group of scenarios plotted corresponds to those in Figure 2 B. Changes in supply coupled with static demand leads to variations in the price of water.



Supplementary Figure 11 Desalination-water price relationship: Water price A) and desalination production B) plotted for each ESM in the Arabian Peninsula. The group of scenarios plotted corresponds to those in Figure 2 E. The price of water increases as alternative sources of water, such as desalination, are used.



Supplementary Figure 12 First node of regression tree of economic impact: The first factor in a CART regression of the economic impact of water scarcity summed over time. All dimensions in the experimental design are the most influential factor in determining economic impact in some basin. Basins are shaded according to the magnitude of their variance.

	Percent
	Positive
Hydrologic Basin	Scenarios
Adriatic Sea-Greece-Black Sea Coast	82.1
Africa-East Central Coast	58.7
Africa-Indian Ocean Coast	70.7
Africa-North Interior	89.7
Africa-North West Coast	85.4
Africa-Red Sea-Gulf of Aden Coast	49
Africa-South Interior	23
Africa-West Coast	78.9
Amazon	94.4
Amu Darya	27.9
Amur	85.1
Angola-Coast	66.6
Arabian Peninsula	30.6
Arabian Sea Coast	62.4
Arctic Ocean Islands	95
Arkansas White Red	91.6
Atlantic Ocean Seaboard	95.7
Australia-East Coast	83.9

	Percent
	Positive
Hydrologic Basin	Scenarios
Australia-Interior	94
Australia-North Coast	92.2
Australia-South Coast	81.4
Australia-West Coast	75.8
Baja California	63.3
Baltic Sea Coast	87.4
Bay of Bengal-North East Coast	1.9
Black Sea-North Coast	92.7
Black Sea-South Coast	77.4
Bo Hai-Korean Bay-North Coast	82.4
Brahamani	0.3
California River	76.7
Caribbean	89.9
Caribbean Coast	86.5
Caspian Sea Coast	83.7
Caspian Sea-East Coast	52.6
Caspian Sea-South West Coast	54.3
Cauvery	19.5
Central Iran	31.7
Central Patagonia Highlands	56.2
Chao Phraya	16.1
China Coast	89.4
Churchill	34.8
Colombia-Ecuador-Pacific Coast	36.6
Congo	33.8
Danube	35.9
Daugava	93.6
Dead Sea	43.3
Denmark-Germany Coast	59.8
Dnieper	93.9
Dniester	92
Don	78.4
Douro	56.3
East Brazil-South Atlantic Coast	50
Eastern Jordan-Syria	24.3
Ebro	88.2
Elbe	93.6
Ems-Weser	63.7
England and Wales	68

	Percent
	Positive
Hydrologic Basin	Scenarios
Farahrud	64.9
Finland	59.1
Fly	18.3
France-South Coast	89.4
France-West Coast	59.4
Fraser	96
Ganges-Bramaputra	77.1
Gironde	79.9
Gobi Interior	87.7
Godavari	39.9
Great	84.2
Great Lakes	55.7
Grijalva-Usumacinta	30.3
Guadalquivir	35.1
Guadiana	25.2
Gulf of Guinea	35.7
Gulf of Thailand Coast	92.5
Hainan	68.7
Hamun-i-Mashkel	57.7
Hawaii	45
Helmand	74.8
Hong-Red River	35.7
Huang He	82.6
Hudson Bay Coast	46.8
Iceland	78.4
India East Coast	17.8
India North East Coast	18
India South Coast	38.3
India West Coast	0.3
Indus	33.9
Ireland	58.7
Irian Jaya Coast	92.1
Irrawaddy	56.4
Isthmus of Tehuantepec	73.8
Italy-East Coast	92.3
Italy-West Coast	92.9
Japan	65.7
Java-Timor	83.1
Kalimantan	92.7

Hydrologic Basin Kara Sea Coast Frishna La Plata La Plata La Puna Region Lake Chad Limpopo Loire Lower Colorado River Lower Mississippi River Madasgacar Madasgacar Mahandi Mahi Mahi Mahi Mahi Mediterranean Sea Islands Mediterranean South Coast Mexico-Interior Mexico-Northwest Coast Narwa Negro Narva Negro New England Niger North Argentina-South Atlantic Coast Nackenzie Macsacar Positive Scenarios 42.2 42.2 42.3 La Plata 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 44.5 Positive 92.3 40.4 42.2 44.5 Positive 94.5 42.2 42.2 42.2 42.2 44.5 Positive 94.5 42.2 42.2 42.2 42.2 42.2 42.2 42.2 42.2 44.5 Positive 94.5 42.2 42.6 43.6 Niger 43.6 Niger 43.6 Niger 43.6 North Argentina-South Atlantic Coast 73.2 North Borneo Coast 47.6		Percent
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	North Borneo Coast	47.6

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Coast 82.8 Northern Dvina 92.3 Northwest Territories 33.8 Ob 61.1 Oder 95 Ohio River 91 Orange 85.7 Orinoco 62.3 Pacific and Arctic Coast 95 Pacific Central Coast 58.1 Pacific Northwest 76.8 Palau and East Indonesia 93 Pampas Region 84.8 Papaloapan 62.5 Papua New Guinea Coast 83.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	North Gulf	33.3
Northern Dvina 92.3 Northwest Territories 33.8 Ob 61.1 Oder 95 Ohio River 91 Orange 85.7 Orinoco 62.3 Pacific and Arctic Coast 95 Pacific Central Coast 58.1 Pacific Northwest 76.8 Palau and East Indonesia 93 Pampas Region 84.8 Papaloapan 62.5 Papua New Guinea Coast 83.6 Perinsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1		
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Orinoco 62.3 Pacific and Arctic Coast 95 Pacific Central Coast 58.1 Pacific Northwest 76.8 Palau and East Indonesia 93 Pampas Region 84.8 Papaloapan 62.5 Papua New Guinea Coast 83.6 Parnaiba 68.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Red Sea-East Coast 1.5 Rehone 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Ohio River	91
Pacific and Arctic Coast 95 Pacific Central Coast 58.1 Pacific Northwest 76.8 Palau and East Indonesia 93 Pampas Region 84.8 Papaloapan 62.5 Papua New Guinea Coast 83.6 Parnaiba 68.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Pen 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Orange	85.7
Pacific Central Coast Pacific Northwest 76.8 Palau and East Indonesia 93 Pampas Region 84.8 Papaloapan 62.5 Papua New Guinea Coast Parnaiba 68.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast Peru-Pacific Coast Philippines 94.2 Plateau of Tibet Interior 90 Poland Coast Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 65.3	Orinoco	62.3
Pacific Northwest76.8Palau and East Indonesia93Pampas Region84.8Papaloapan62.5Papua New Guinea Coast83.6Parnaiba68.6Peninsula Malaysia89.5Pennar14.6Persian Gulf Coast56.3Peru-Pacific Coast57.8Philippines94.2Plateau of Tibet Interior33.8Po91.9Poland Coast91.5Red Sea-East Coast1.5Rhine64Rhone61.3Rift Valley43.1Rio Balsas64.1	Pacific and Arctic Coast	95
Palau and East Indonesia93Pampas Region84.8Papaloapan62.5Papua New Guinea Coast83.6Parnaiba68.6Peninsula Malaysia89.5Pennar14.6Persian Gulf Coast56.3Peru-Pacific Coast57.8Philippines94.2Plateau of Tibet Interior33.8Po91.9Poland Coast91.5Red Sea-East Coast1.5Rhine64Rhone61.3Rift Valley43.1Rio Balsas64.1	Pacific Central Coast	58.1
Pampas Region 84.8 Papaloapan 62.5 Papua New Guinea Coast 83.6 Parnaiba 68.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Pacific Northwest	76.8
Papaloapan 62.5 Papua New Guinea Coast 83.6 Parnaiba 68.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Palau and East Indonesia	93
Papua New Guinea Coast 83.6 Parnaiba 68.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Pampas Region	84.8
Parnaiba 68.6 Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Papaloapan	62.5
Peninsula Malaysia 89.5 Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Papua New Guinea Coast	83.6
Pennar 14.6 Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Parnaiba	68.6
Persian Gulf Coast 56.3 Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Peninsula Malaysia	89.5
Peru-Pacific Coast 57.8 Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Pennar	14.6
Philippines 94.2 Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Persian Gulf Coast	56.3
Plateau of Tibet Interior 33.8 Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Peru-Pacific Coast	57.8
Po 91.9 Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Philippines	94.2
Poland Coast 91.5 Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Plateau of Tibet Interior	33.8
Red Sea-East Coast 1.5 Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Ро	91.9
Rhine 64 Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Poland Coast	91.5
Rhone 61.3 Rift Valley 43.1 Rio Balsas 64.1	Red Sea-East Coast	1.5
Rift Valley 43.1 Rio Balsas 64.1	Rhine	64
Rio Balsas 64.1	Rhone	61.3
Rio Balsas 64.1	Rift Valley	43.1
	, , , , , , , , , , , , , , , , , , ,	64.1
Rio Grande River 54	Rio Grande River	54
Rio Lerma 46.9	Rio Lerma	46.9
Rio Verde 49.6	Rio Verde	
Russia-Barents Sea Coast 92.6	Russia-Barents Sea Coast	
Russia-South East Coast 73.2		
Sabarmati 34.9		1

Salween Sao Francisco Saskatchewan-Nelson Scandinavia-North Coast	
Salinas Grandes Salween Sao Francisco Saskatchewan-Nelson Scandinavia-North Coast	86.1 66.2 94.5 69.7 76.7 91.2
Salween Sao Francisco Saskatchewan-Nelson Scandinavia-North Coast	66.2 94.5 69.7 76.7 91.2
Sao Francisco Saskatchewan-Nelson Scandinavia-North Coast	94.5 69.7 76.7 91.2
Saskatchewan-Nelson Scandinavia-North Coast	69.7 76.7 91.2
Scandinavia-North Coast	76.7 91.2
	91.2
Scheldt	
l	58.9
Scotland	
Seine	81.8
Senegal	53.3
Sepik	11.2
Shebelli-Juba	57.1
Siberia-North Coast	92.4
Siberia-West Coast	62
Sinai Peninsula	49.8
Sittang	59.2
Solomon Islands	10.1
South Africa-South Coast	92.7
South Africa-West Coast	88.5
South America-Colorado	82.8
South Argentina-South Atlantic Coast	79.8
South Atlantic Gulf	93.7
South Chile-Pacific Coast	89.4
South China Sea Coast	73.1
South Pacific Islands	10
Southern Central America	36.9
Spain-Portugal-Atlantic Coast	65.4
	46.8
Sri Lanka	65.2
St Lawrence	86.3
	92.4
Sumatra	79.4
Sweden	82.5
Syr Darya	49.2
	64.6
	94.7
	48.3
·	85.3
	90.1
Tennessee River	95

	Percent
	Positive
Hydrologic Basin	Scenarios
Texas Gulf Coast	92.6
Tiber	66.8
Tigris-Euphrates	28
Tocantins	67.6
Upper Colorado River	94.3
Upper Mississippi	90.8
Ural	42.1
Uruguay-Brazil-South Atlantic Coast	82.2
Viet Nam-Coast	43.9
Volga	86.5
Volta	16.5
Wisla	91
Xun Jiang	69.3
Yangtze	79.8
Yasai	1.3
Yenisey	76.4
Yucatan Peninsula	69.1
Zambezi	65.3
Ziya He-Interior	89.6

SI Table 1: Percent positive scenarios in each basin across the scenario ensemble.