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Supplementary Information for:

The impact of flooding on food security across Africa

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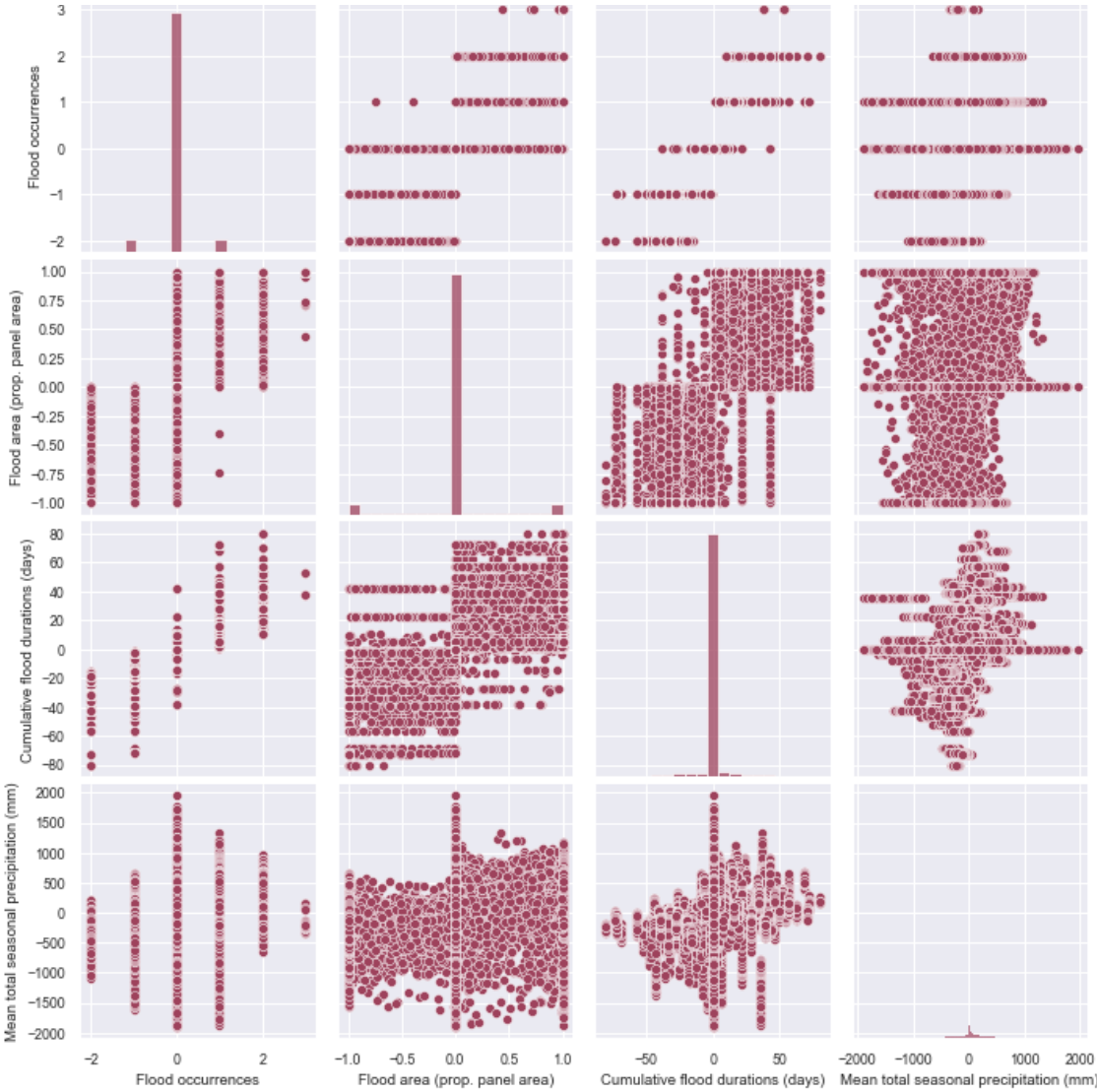


SI Figure 1. Plots of covariates included in Granger model and regional and country panel models. We further include precipitation here to better understand and interpret key covariates (e.g. flood duration), although precipitation was not included in the Granger and panel models in the main manuscript.

SI Table 1: Variance explained for all static random effects panel models.
The $\chi 2$ statistic for all models is significant at the .001 level (indicated by ***) with 15 degrees of freedom. The number of observations N is a product of the number of panels within the model's spatial extent with the number of observations for each panel in time.

	Full dataset							**Granger-filtered dataset**						
Model	n	T	N	R^2	Adjusted R^2	DF	χ^2	n	T	N	R^2	Adjusted R^2	DF	χ^2
All-Africa	6588	11–35	223962	0.018522	0.018457	15	277.261 ***	1793	34	60962	0.05335	0.063117	15	266.205 ***
East Africa	2835	34	96390	0.026142	0.025991	15	197.971 ***	714	34	24276	0.082399	0.081832	15	268.612 ***
Southeast Africa	1378	11–35	46822	0.027986	0.027675	15	504.986 ***	308	34	10472	0.094692	0.093393	15	401.043 ***
West Africa	2375	34	80750	0.029636	0.029456	15	462.925 ***	771	34	26214	0.061166	0.060628	15	218.511 ***
Burkina Faso	127	34	4318	0.10631	0.1032	15	1150.48 ***	22	34	748	0.15621	0.13892	15	587.493 ***
Chad	152	34	5168	0.036925	0.034121	15	13924 ***	0	0	0	NA	NA	NA	NA
Ethiopia	758	34	25772	0.01231	0.011735	15	507.717 ***	7	34	238	0.078354	0.01608	15	2165.27 ***
Kenya	612	34	20808	0.057218	0.056538	15	51.5677 ***	216	34	7344	0.083444	0.081568	15	97.475 ***
Malawi	168	26–34	5704	0.13547	0.13319	15	710.297 ***	105	34	3570	0.23186	0.22862	15	497.136 ***
Mali	206	34	7004	0.050769	0.048731	15	1343.29 ***	7	34	238	0.37614	0.33399	15	980.215 ***
Mozambique	468	34	15912	0.05684	0.05595	15	299.096 ***	202	34	6868	0.098235	0.096261	15	175.63 ***
Niger	249	34	8466	0.113	0.11142	15	388.928 ***	179	34	6086	0.14858	0.14648	15	357.294 ***
Nigeria	1501	34	51034	0.043648	0.043367	15	123.119 ***	563	34	19142	0.055642	0.054901	15	121.364 ***
Somalia	157	34	8738	0.005500	0.0037898	15	740.689 ***	0	0	0	NA	NA	15	NA
South Sudan	226	34	7684	0.15921	0.15757	15	796.569 ***	181	34	6154	0.18623	0.18424	15	732.45 ***
Sudan	484	34	16456	0.06241	0.061555	15	678.186 ***	201	34	6834	0.14575	0.14387	15	733.855 ***
Uganda	498	34	16932	0.018175	0.017304	15	39.1533 ***	106	34	3604	0.060987	0.057062	15	68.7726 ***

Zambia	318	11–35	10790	0.012879	0.011504	15	48740.9***	0	0	0	NA	NA	15	NA
Zimbabwe	424	34	14416	0.015717	0.014691	15	274.757***	0	0	0	NA	NA	15	NA

SI Table 2a: Coefficient estimates, clustered standard errors, and p-values for all static random effects panel models fit on full dataset.

		Full dataset											
		All-Africa			West Africa + Chad			East Africa			South Africa		
Coefficient		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	-0.005986	0.041387	0.884997	-0.106132	0.068408	0.120793	0.067318	0.055336	0.223784	0.039382	0.034458	0.253077
	t-1	0.011343	0.047733	0.812156	-0.075508	0.070477	0.284000	-0.002893	0.058498	0.960557	0.108791	0.071973	0.130650
	t-2	0.098943	0.042705	0.020510	0.045532	0.078860	0.563679	0.050475	0.069408	0.467096	0.164885	0.076910	0.032044
	t-3	0.049997	0.041348	0.226597	0.062516	0.052024	0.229492	-0.036552	0.065152	0.574775	0.101953	0.087774	0.245421
	t-4	-0.044338	0.031088	0.153806	-0.075852	0.038578	0.049276	-0.026430	0.048116	0.582810	-0.103585	0.064936	0.110667
Flood area (first-differenced prop. panel area)	t	-0.025460	0.021723	0.241185	0.048291	0.036024	0.180070	-0.086949	0.022116	0.000084	-0.042371	0.028389	0.135570
	t-1	-0.050961	0.032153	0.112985	-0.019537	0.038045	0.607590	-0.085890	0.029681	0.003806	-0.014111	0.039712	0.722341
	t-2	-0.009759	0.047054	0.835691	0.022307	0.077715	0.774084	-0.033624	0.034449	0.329039	0.031979	0.074692	0.668545
	t-3	-0.011484	0.046123	0.803379	0.069611	0.083719	0.405697	-0.002656	0.024960	0.915261	-0.084166	0.084245	0.317759
	t-4	0.005709	0.026485	0.829346	0.027623	0.055436	0.618282	-0.004091	0.020586	0.842458	0.011125	0.027219	0.682749
Flood duration (first-differenced days)	t	-0.080013	0.032657	0.014282	-0.002374	0.035781	0.947107	-0.154671	0.064495	0.016477	-0.068604	0.050349	0.173019
	t-1	-0.091004	0.035542	0.010453	0.023695	0.077164	0.758786	-0.094167	0.051738	0.068748	-0.202183	0.078990	0.010479
	t-2	-0.102180	0.046229	0.027083	0.002800	0.077148	0.971053	-0.098245	0.052762	0.062597	-0.165745	0.091451	0.069926

	t-3	-0.050179	0.044595	0.260501	-0.066958	0.051405	0.192726	0.013271	0.056713	0.814979	-0.101741	0.119469	0.394433
	t-4	-0.010428	0.029929	0.727520	-0.012323	0.043683	0.777873	-0.019430	0.037004	0.599530	0.059354	0.059954	0.322179
		Burkina Faso			Chad			Ethiopia			Kenya		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	-0.941521	0.471524	0.045851	-0.802290	0.102115	0.000000	-0.218435	0.103462	0.034751	0.135177	0.080239	0.092051
	t-1	-0.123878	0.341107	0.716482	-0.552713	0.143719	0.000120	-0.367486	0.169434	0.030090	0.076669	0.084914	0.366583
	t-2	-0.119150	0.291848	0.683083	-0.675552	0.127407	0.000000	-0.284468	0.213496	0.182718	-0.049603	0.088711	0.576053
	t-3	-0.627615	0.259664	0.015648	-0.683388	0.112198	0.000000	-0.100468	0.256610	0.695414	-0.048689	0.063879	0.445940
	t-4	-0.259345	0.166987	0.120404	-0.298003	0.139514	0.032678	0.158016	0.077260	0.040830	-0.080094	0.057631	0.164596
Flood area (first-differenced prop. panel area)	t	-0.052500	0.175192	0.764429	0.125590	0.035893	0.000467	-0.040858	0.057445	0.476932	-0.100993	0.050017	0.043469
	t-1	-0.133153	0.106006	0.209082	0.053947	0.056889	0.342989	-0.204958	0.126492	0.105164	-0.126969	0.063379	0.045144
	t-2	0.022435	0.113549	0.843370	0.181806	0.104278	0.081252	-0.096530	0.117869	0.412807	-0.008386	0.055177	0.879198
	t-3	0.168951	0.134899	0.210413	0.291832	0.108458	0.007130	-0.072879	0.106071	0.492034	-0.057146	0.044089	0.194924
	t-4	0.088424	0.066307	0.182347	0.048531	0.103686	0.639744	-0.105789	0.054005	0.050126	0.032117	0.038422	0.403208
Flood duration (first-differenced days)	t	0.700135	0.409661	0.087440	0.714448	0.143227	0.000001	0.048537	0.108588	0.654885	-0.279202	0.105372	0.008057
	t-1	-0.044345	0.339921	0.896206	0.451329	0.155273	0.003653	0.344395	0.180604	0.056533	-0.092746	0.089136	0.298106
	t-2	-0.047945	0.283599	0.865751	0.630730	0.163918	0.000119	0.327855	0.231769	0.157193	-0.005803	0.063735	0.927454

	t-3	0.430618	0.223665	0.054194	0.575562	0.142816	0.000056	0.144869	0.251171	0.564093	0.030236	0.049030	0.537437
	t-4	0.059224	0.133573	0.657488	0.105857	0.111197	0.341108	-0.106459	0.099755	0.285879	0.003659	0.042231	0.930954
		Malawi			Mali			Mauritania			Mozambique		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	0.149593	0.063544	0.018565	-0.314788	0.144663	0.029555				0.026198	0.041338	0.526236
	t-1	0.147257	0.116200	0.205060	-0.278417	0.129358	0.031374				0.164567	0.121237	0.174655
	t-2	0.132097	0.079022	0.094593	-0.140499	0.116606	0.228241				0.229332	0.094884	0.015651
	t-3	0.166625	0.084384	0.048313	-0.029990	0.114802	0.793913				0.165267	0.086853	0.057062
	t-4	-0.046902	0.061867	0.448387	-0.123846	0.145021	0.393112				-0.179420	0.099635	0.071740
Flood area (first-differenced prop. panel area)	t	-0.137202	0.046109	0.002924	-0.218035	0.079442	0.006059				0.001929	0.031477	0.951134
	t-1	-0.110157	0.059630	0.064699	0.153086	0.091044	0.092676				0.022550	0.051039	0.658620
	t-2	0.245133	0.137485	0.074588	-0.081262	0.118675	0.493506				-0.010795	0.063635	0.865299
	t-3	-0.189030	0.180216	0.294220	-0.023407	0.099505	0.814027				-0.053988	0.075045	0.471885
	t-4	0.082817	0.108072	0.443486	0.164517	0.091636	0.072601				0.065391	0.024757	0.008260
Flood duration (first-differenced days)	t	-0.127120	0.063742	0.046119	-0.002538	0.099747	0.979701				-0.070421	0.040758	0.084024
	t-1	-0.179983	0.104202	0.084124	-0.101782	0.093124	0.274406				-0.256500	0.109025	0.018639
	t-2	-0.171398	0.096558	0.075886	0.224152	0.094016	0.017117				-0.232382	0.082369	0.004784

	t-3	-0.053368	0.170484	0.754253	-0.054248	0.132346	0.681884				-0.196039	0.087290	0.024714
	t-4	0.000099	0.079277	0.999006	-0.147656	0.104060	0.155913				0.082307	0.077196	0.286330
		Niger			Nigeria			Somalia			South Sudan		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	-0.254555	0.086731	0.003336	-0.013686	0.038641	0.723204	-0.313202	0.211228	0.138136	0.165505	0.062461	0.008055
	t-1	-0.049484	0.111111	0.656061	-0.041169	0.043328	0.342021	-0.144039	0.186935	0.440985	-0.085608	0.101985	0.401233
	t-2	-0.101960	0.098200	0.299136	0.149111	0.067481	0.027128	-0.174338	0.227413	0.443310	0.093237	0.073157	0.202491
	t-3	-0.051819	0.112728	0.645741	0.150658	0.061426	0.014180	0.133706	0.191547	0.485157	-0.269971	0.080834	0.000838
	t-4	-0.045927	0.060676	0.449099	-0.031265	0.047146	0.507233	0.058702	0.184034	0.749746	-0.202374	0.086858	0.019810
Flood area (first-differenced prop. panel area)	t	0.020289	0.053941	0.706819	0.011323	0.015227	0.457108	-0.037325	0.051568	0.469182	-0.133186	0.055267	0.015958
	t-1	-0.066031	0.072478	0.362269	-0.071266	0.021570	0.000953	-0.282040	0.056052	0.000000	-0.020856	0.063648	0.743151
	t-2	0.055866	0.101795	0.583137	-0.048127	0.047626	0.312252	-0.293637	0.093905	0.001766	-0.135808	0.080027	0.089693
	t-3	0.141944	0.102333	0.165418	-0.026436	0.050398	0.599901	-0.260940	0.067732	0.000117	0.008589	0.038603	0.823939
	t-4	0.096780	0.069192	0.161897	-0.059244	0.051938	0.254007	-0.205914	0.086646	0.017478	-0.021004	0.032609	0.519491
Flood duration (first-differenced days)	t	0.063421	0.053929	0.239590	-0.030450	0.024600	0.215779	0.130000	0.116334	0.263790	-0.287327	0.080916	0.000384
	t-1	-0.075348	0.099762	0.450078	0.110580	0.082333	0.179243	-0.238537	0.266660	0.371034	-0.153893	0.087225	0.077677
	t-2	0.072577	0.087945	0.409226	-0.043021	0.107394	0.688718	0.561743	0.365995	0.124824	-0.086796	0.070212	0.216389

	t-3	-0.050601	0.102899	0.622890	-0.080989	0.063247	0.200367	-0.200106	0.340159	0.556350	0.236222	0.085588	0.005780
	t-4	-0.097847	0.053140	0.065577	0.018994	0.049398	0.700596	0.160440	0.156746	0.306039	0.070143	0.063103	0.266326
		Sudan			Uganda			Zambia			Zimbabwe		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	0.038258	0.082551	0.643048	-0.061092	0.047664	0.199942	0.011004	0.019117	0.564891	-0.093051	0.068663	0.175360
	t-1	-0.045479	0.085698	0.595634	-0.003914	0.066747	0.953235	0.057234	0.029531	0.052612	0.181801	0.169644	0.283872
	t-2	0.117556	0.039694	0.003061	0.066528	0.097244	0.493890	0.241249	0.051117	0.000002	0.125471	0.204276	0.539068
	t-3	0.147313	0.077465	0.057216	0.066100	0.042462	0.119544	-0.083536	0.028096	0.002946	0.133782	0.255824	0.601012
	t-4	0.087304	0.082143	0.287861	-0.001639	0.048808	0.973206	0.015657	0.013682	0.252507	0.029489	0.215539	0.891177
Flood area (first-differenced prop. panel area)	t	-0.097275	0.050821	0.055612	-0.039641	0.029403	0.177596	0.056998	0.025829	0.027334	-0.134647	0.063483	0.033922
	t-1	-0.105364	0.055077	0.055742	-0.045824	0.025262	0.069687	0.085400	0.039427	0.030311	-0.034986	0.071217	0.623240
	t-2	0.042094	0.062165	0.498318	0.000619	0.030653	0.983877	-0.106891	0.045233	0.018121	-0.313714	0.083118	0.000160
	t-3	0.112514	0.043460	0.009629	-0.025728	0.019989	0.198063	0.045702	0.030312	0.131624	-0.248458	0.092159	0.007018
	t-4	-0.019106	0.060373	0.751652	0.002511	0.017034	0.882788	0.020592	0.016542	0.213188	-0.201490	0.099583	0.043039
Flood duration (first-differenced days)	t	-0.070768	0.070123	0.312880	0.128523	0.076298	0.092087	-0.041966	0.039871	0.292558	0.210917	0.127352	0.097687
	t-1	-0.023736	0.066595	0.721520	0.051887	0.060027	0.387372	-0.097963	0.034673	0.004723	-0.280027	0.199190	0.159774
	t-2	-0.187585	0.049670	0.000159	-0.095029	0.119963	0.428271	-0.113505	0.041102	0.005753	0.160420	0.254038	0.527727

	t-3	-0.172536	0.080691	0.032498	-0.077607	0.072786	0.286317	0.243859	0.076763	0.001489	0.130176	0.267210	0.626139
	t-4	-0.038350	0.091934	0.676574	0.037813	0.043076	0.380039	-0.050448	0.035105	0.150695	0.086846	0.212202	0.682350

SI Table 2b: Coefficient estimates, clustered standard errors, and p-values for all static random effects panel models fit on Granger-filtered dataset.

		Granger dataset											
		All-Africa			West Africa + Chad			East Africa			South Africa		
Coefficient		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	-0.005780	0.053477	0.913933	-0.167541	0.079037	0.034025	0.146791	0.062156	0.018194	0.024304	0.084273	0.773045
	t-1	0.004639	0.076721	0.951785	-0.113047	0.099358	0.255213	0.022805	0.081259	0.778981	0.109307	0.198579	0.582016
	t-2	0.160244	0.060154	0.007724	0.056191	0.109072	0.606434	0.153490	0.075791	0.042851	0.194616	0.241021	0.419399
	t-3	0.047775	0.072671	0.510913	0.072382	0.080563	0.368944	-0.066465	0.108647	0.540700	0.046901	0.193070	0.808064
	t-4	-0.067349	0.044536	0.130468	-0.070513	0.053817	0.190117	-0.050198	0.070021	0.473434	-0.223382	0.176863	0.206582
Flood area (first-differenced prop. panel area)	t	-0.038794	0.039037	0.320340	0.079094	0.055644	0.155196	-0.139968	0.042272	0.000929	-0.081585	0.046659	0.080372
	t-1	-0.067181	0.053077	0.205613	-0.037187	0.062761	0.553511	-0.108401	0.039709	0.006336	-0.032137	0.077858	0.679778
	t-2	-0.016366	0.076518	0.830636	0.008188	0.110359	0.940857	-0.076181	0.047726	0.110444	0.083059	0.110998	0.454283
	t-3	-0.021295	0.078194	0.785369	0.083571	0.121876	0.492898	-0.002216	0.045560	0.961208	-0.153891	0.149802	0.304282
	t-4	-0.002212	0.036846	0.952134	0.001114	0.076062	0.988312	-0.014401	0.037908	0.704029	0.059584	0.067674	0.378616
Flood duration (first-differenced days)	t	-0.148860	0.048538	0.002163	-0.031125	0.059231	0.599249	-0.271375	0.087443	0.001913	-0.131992	0.060727	0.029741
	t-1	-0.158011	0.063801	0.013263	0.003738	0.107329	0.972220	-0.195986	0.064839	0.002505	-0.310205	0.144987	0.032392
	t-2	-0.188028	0.080084	0.018881	-0.021189	0.122721	0.862917	-0.208466	0.075416	0.005706	-0.256601	0.180903	0.156061

	t-3	-0.068627	0.078849	0.384103	-0.117925	0.083938	0.160048	0.035063	0.106635	0.742293	-0.113668	0.217168	0.600690
	t-4	-0.018519	0.047652	0.697547	-0.036316	0.064593	0.573962	-0.025783	0.061697	0.676026	0.104583	0.100697	0.298996
		Burkina Faso			Chad			Ethiopia			Kenya		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	-1.084542	0.842392	0.197936				0.182817	0.078873	0.020457	0.198374	0.095323	0.037427
	t-1	0.124584	0.627788	0.842693				-0.152180	0.125094	0.223784	0.153996	0.145847	0.291028
	t-2	-0.073079	0.562924	0.896709				0.158438	0.124230	0.202183	-0.032279	0.167469	0.847157
	t-3	-1.010448	0.542722	0.062629				0.011673	0.168061	0.944627	-0.100837	0.162340	0.534503
	t-4	-0.504415	0.208298	0.015453				-0.025607	0.133928	0.848369	-0.125003	0.145989	0.391859
Flood area (first-differenced prop. panel area)	t	-0.188043	0.321088	0.558114				-0.001615	0.134249	0.990401	-0.173485	0.082154	0.034711
	t-1	-0.243043	0.187291	0.194398				0.349793	0.158855	0.027668	-0.250880	0.118149	0.033719
	t-2	-0.044304	0.209781	0.832739				0.014003	0.136920	0.918543	-0.087046	0.086994	0.317016
	t-3	0.138598	0.248479	0.576989				0.086995	0.109312	0.426125	-0.128074	0.072457	0.077133
	t-4	-0.007959	0.089462	0.929110				0.006518	0.142386	0.963488	0.054724	0.098000	0.576562
Flood duration (first-differenced days)	t	0.914927	0.882565	0.299891				-0.251741	0.076228	0.000958	-0.441148	0.130990	0.000758
	t-1	-0.372074	0.662548	0.574402				-0.131270	0.132053	0.320188	-0.167428	0.160769	0.297681
	t-2	-0.163050	0.568235	0.774157				-0.157155	0.107019	0.141976	-0.039998	0.142920	0.779584

	t-3	0.778265	0.466238	0.095069				-0.118770	0.130096	0.361274	0.085364	0.145099	0.556321
	t-4	0.208798	0.218046	0.338271				-0.070191	0.083883	0.402719	-0.021806	0.115973	0.850853
		Malawi			Mali			Mauritania			Mozambique		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	0.174919	0.075682	0.020820	-0.475912	0.261039	0.068282				-0.036279	0.067646	0.591744
	t-1	0.185805	0.174830	0.287884	-0.538584	0.254193	0.034107				0.270966	0.266066	0.308480
	t-2	0.470625	0.147536	0.001423	-0.094628	0.180345	0.599787				0.333810	0.252302	0.185817
	t-3	0.166730	0.127805	0.192042	-0.048524	0.167553	0.772117				0.187276	0.187913	0.318953
	t-4	0.162266	0.227440	0.475571	-0.340964	0.236733	0.149787				-0.347459	0.184881	0.060194
Flood area (first-differenced prop. panel area)	t	-0.137851	0.043977	0.001721	-0.318841	0.148665	0.031978				0.003499	0.058738	0.952495
	t-1	-0.271898	0.130339	0.036971	-0.059501	0.156240	0.703329				0.029279	0.101405	0.772784
	t-2	0.302170	0.166091	0.068864	-0.405625	0.181412	0.025356				-0.061249	0.125828	0.626422
	t-3	-0.384038	0.235150	0.102435	-0.110078	0.245395	0.653738				-0.099265	0.134127	0.459250
	t-4	0.092547	0.098100	0.345482	-0.035174	0.247493	0.886983				0.128079	0.057224	0.025208
Flood duration (first-differenced days)	t	-0.216960	0.053100	0.000044	0.042681	0.151487	0.778137				-0.098664	0.082631	0.232464
	t-1	-0.229565	0.134179	0.087103	-0.010667	0.183127	0.953551				-0.501057	0.250504	0.045479
	t-2	-0.353038	0.138368	0.010728	0.330716	0.132282	0.012416				-0.390859	0.206875	0.058846

	t-3	0.017393	0.215437	0.935654	-0.014727	0.154946	0.924281				-0.313393	0.185902	0.091836
	t-4	-0.108341	0.121813	0.373788	0.001797	0.124924	0.988526				0.137081	0.140073	0.327760
		Niger			Nigeria			Somalia			South Sudan		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	-0.331263	0.109760	0.002544	-0.044247	0.047312	0.349672				0.241538	0.074962	0.001272
	t-1	-0.058815	0.149412	0.693845	-0.084049	0.063209	0.183622				-0.133461	0.138596	0.335571
	t-2	-0.134873	0.135355	0.319039	0.185209	0.105304	0.078612				0.152705	0.088116	0.083095
	t-3	-0.094232	0.157515	0.549680	0.181962	0.097268	0.061383				-0.352393	0.105569	0.000844
	t-4	-0.059997	0.075647	0.427705	-0.049152	0.060610	0.417393				-0.239469	0.105376	0.023055
Flood area (first-differenced prop. panel area)	t	0.007554	0.069683	0.913672	0.027615	0.024624	0.262077				-0.195438	0.083867	0.019788
	t-1	-0.108362	0.098885	0.273152	-0.087087	0.028797	0.002493				-0.018988	0.096164	0.843471
	t-2	0.057903	0.137435	0.673526	-0.065694	0.057727	0.255115				-0.195318	0.107645	0.069606
	t-3	0.188467	0.147111	0.200151	-0.037520	0.065821	0.568662				-0.001983	0.057915	0.972681
	t-4	0.108373	0.093202	0.244919	-0.083856	0.064457	0.193271				-0.050178	0.045972	0.275060
Flood duration (first-differenced days)	t	0.084240	0.069983	0.228694	-0.056584	0.046074	0.219408				-0.397995	0.104217	0.000134
	t-1	-0.102122	0.139993	0.465708	0.145808	0.107644	0.175563				-0.201771	0.120512	0.094076
	t-2	0.102229	0.124003	0.409706	-0.076106	0.167451	0.649469				-0.128704	0.095956	0.179829

	t-3	-0.055485	0.149373	0.710302	-0.116437	0.090507	0.198269				0.329149	0.117058	0.004926
	t-4	-0.131585	0.070265	0.061111	0.036190	0.074629	0.627726				0.094765	0.082799	0.252406
		Sudan			Uganda			Zambia			Zimbabwe		
		Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value	Estimate	SE	p-value
Flood occurrences (first-differenced)	t	0.148371	0.084340	0.078544	-0.113480	0.081220	0.162353	NA			NA		
	t-1	-0.061927	0.128366	0.629506	0.014705	0.143023	0.918108						
	t-2	0.213599	0.063310	0.000741	0.179202	0.181899	0.324539						
	t-3	0.296760	0.093521	0.001508	0.145861	0.066801	0.028999						
	t-4	0.188727	0.079230	0.017218	0.091517	0.092270	0.321273						
Flood area (first-differenced prop. panel area)	t	-0.118148	0.059223	0.046045	-0.073212	0.053271	0.169340						
	t-1	-0.105712	0.099508	0.288081	-0.074411	0.053023	0.160503						
	t-2	0.132830	0.097602	0.173533	-0.017463	0.059504	0.769154						
	t-3	0.228058	0.079521	0.004132	-0.085081	0.033611	0.011361						
	t-4	0.025779	0.093803	0.783453	-0.048291	0.029076	0.096747						
Flood duration (first-differenced days)	t	-0.222653	0.073533	0.002462	0.204212	0.107492	0.057460						
	t-1	-0.064928	0.094480	0.491950	0.045270	0.115066	0.694005						
	t-2	-0.355320	0.066383	0.000000	-0.217181	0.208256	0.297014						
	t-3	-0.373209	0.109234	0.000634	-0.156057	0.123692	0.207073						

	t-4	-0.138607	0.109788	0.206770	0.003424	0.074008	0.963099		

SI Table 3a: Summary statistics of full dataset (n = 6589, T = 39–40).

Full dataset							
Variable	Mean	SD	Min	P25	P50	P75	Max
Mean IPC	1.413867	0.62994	1	1	1	1.941356	5
Flood occurrences	0.07116729	0.2819388	0	0	0	0	3
Total flood area (km^2)	85.44208	1132.235	0	0	0	0	278867.4
Total flood area (%)	0.05344657	0.2186602	0	0	0	0	1
Cumulative flood duration (days)	1.4901	7.162494	0	0	0	0	80

SI Table 3b: Summary statistics of Granger-filtered dataset (n = 1793, T = 39).

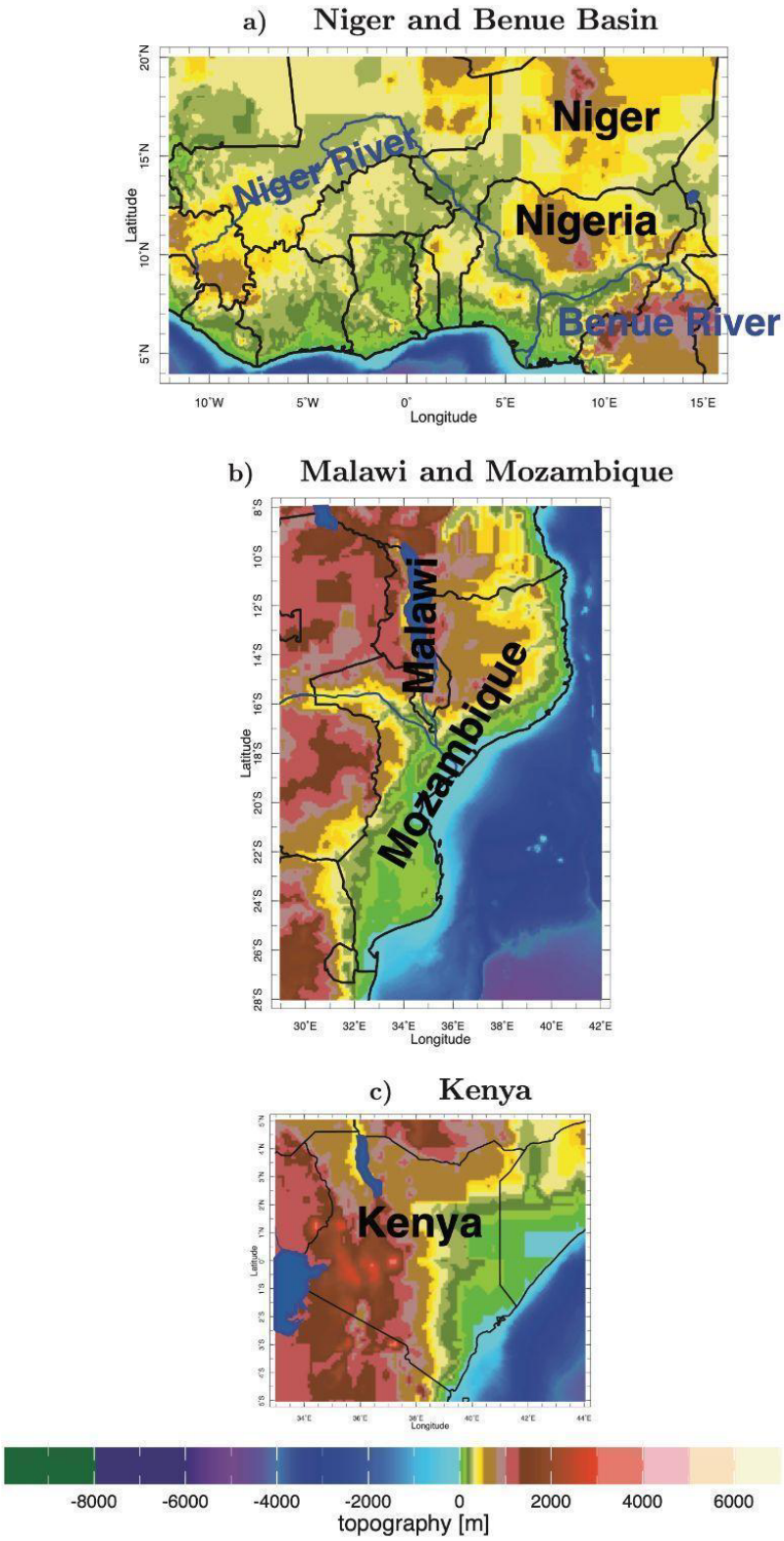
Granger-filtered dataset							
Variable	Mean	SD	Min	P25	P50	P75	Max
Mean IPC	1.460312	0.631268	1	1	1.01865	1.976832	4.60265
Flood occurrences	0.1519871	0.3962016	0	0	0	0	3
Total flood area (km^2)	205.3844	1255.9	0	0	0	0	79439.39
Total flood area (%)	0.1142893	0.3085196	0	0	0	0	1
Cumulative flood duration (days)	3.312497	10.48428	0	0	0	0	80

SI Table 4: Results of the cross-sectionally augmented Im, Pesaran, and Shin tests for unit roots across variables. Results are only presented on the Granger-filtered dataset due to singularity issues arising from limited variance of certain variables in the full dataset. The null hypothesis for each of these tests is that the time series of the specified variable contains a unit root across panels in the dataset (i.e. is non-stationary). The lag order used for all variables in these tests was 4. First-differenced variables take the form $y_t = x_t - x_{t-1}$, while deseasoned variables take the form $y_{t_s} = x_{t_s} - x_{t_{s-1}}$ where *s* indicates a particular season (manually labeled in the data due to historical changes in reporting periods).

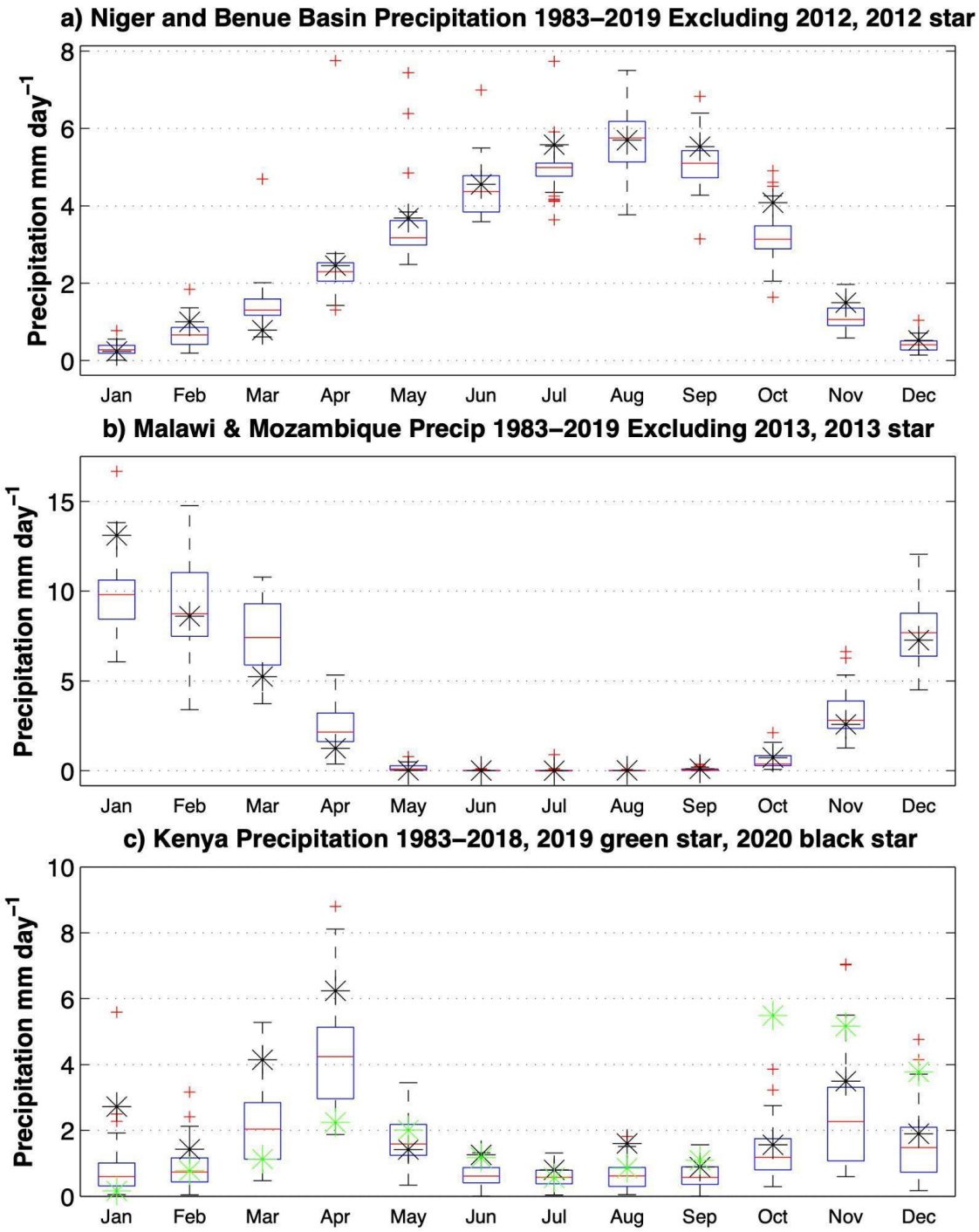
	Granger-filtered dataset							
	Variable in levels		Variable in first differences		Deseasoned variable in levels		Deseasoned variable in first differences	
Variable	Statistic	p-value	Statistic	p-value	Statistic	p-value	Statistic	p-value
Mean IPC	-2.3264	>0.1	-3.1792	<0.01*	-2.7565	<0.01*	-3.3134	<0.01*
Flood occurrences	-2.6838	<0.01*	-3.7942	<0.01*	-2.75	<0.01*	-3.923	<0.01*
Total flood area (%)	-2.6121	0.01731	-3.6637	<0.01*	-2.6524	<0.01*	-3.5086	<0.01*
Total flood duration (days)	-2.424	>0.1	-3.5697	<0.01*	-2.9587	<0.01*	-3.6428	<0.01*

SI Table 5: Results of the Pesaran CD test for cross sectional dependence across variables in the Granger-filtered dataset. The null hypothesis of each of these tests is cross-sectional independence in the given variable. *** indicates that the test statistic is significant at the 0.001 level.

	Granger-filtered dataset			
	Variables			
	Mean IPC	Flood occurrences	Total flood area (%)	Cumulative flood duration (days)
Absolute value mean correlation coefficient	0.26214	0.23518	0.22933	0.20597
Mean correlation coefficient	0.14965	0.11389	0.10801	0.10278
CD test statistic	1181.4 ***	901.47 ***	854.92 ***	813.52 ***



SI Figure 2. Topographic variation for each of the regions/countries of focus for this study.



SI Figure 3. Monthly precipitation distributions (box plots) and focus flood events (black and green stars) for each of the regions/countries included in the case studies in our analysis. Boxplots were created with all data excluding the case study flood years. The lower edge of the box is the 25th percentile, the middle is the median (50th percentile), and the top is the 75th percentile of precipitation over the years for the month on the x-axis. The whiskers extend to encompass 99.3% of normally distributed data and the outliers (red crosses) are values considered outside this distribution.

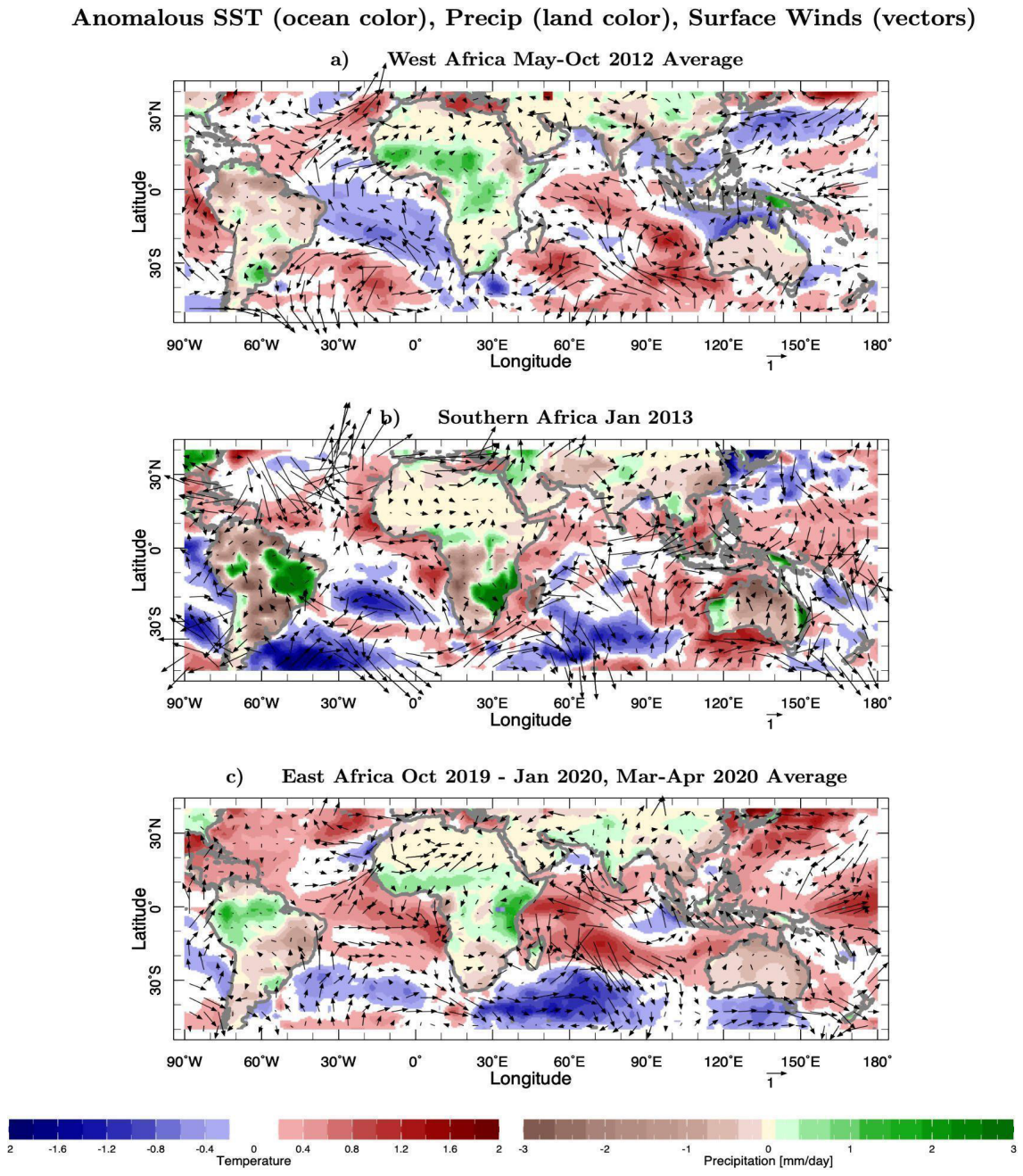


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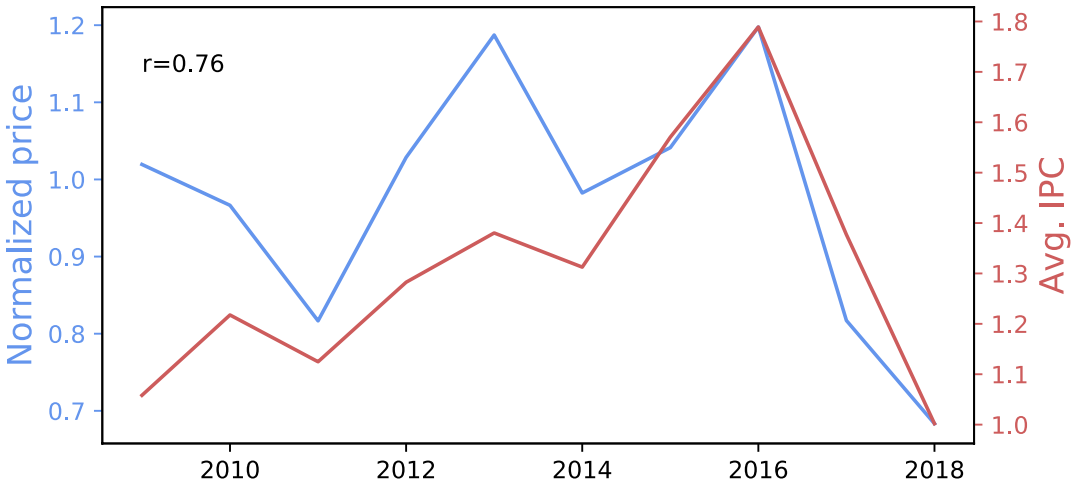
Figure 4: Anomalous (from 1983-2020 baseline) sea surface temperatures (oceans and blue-red colorbar), surface winds (vectors), and terrestrial precipitation (land and brown-green colorbar) overlapping major flood periods, as described in the narrative case studies, for (a) West Africa, May-Oct 2012, (b) southern Africa, Jan 2013 and (c) East Africa Oct 2019- Jan 2020.

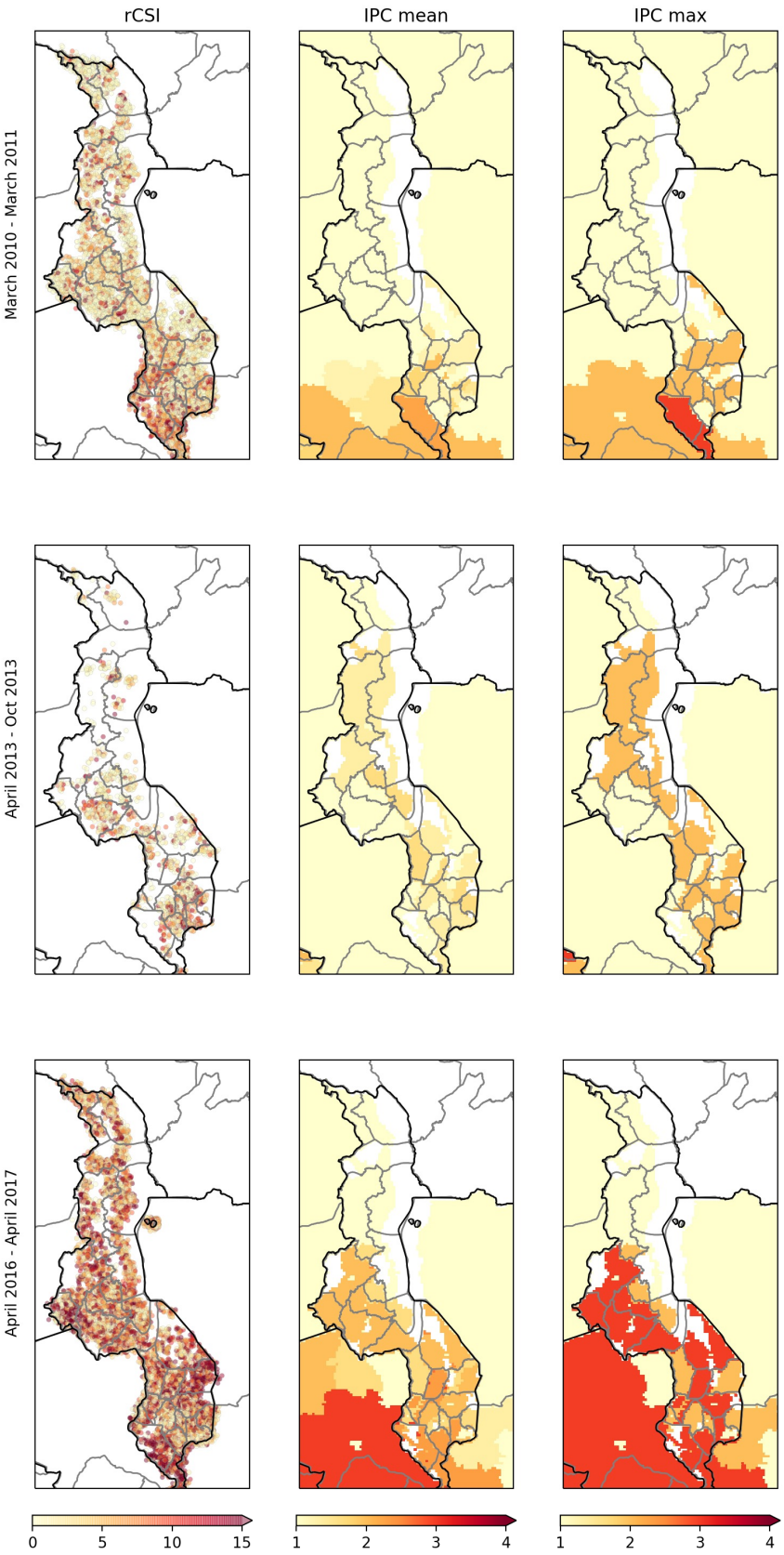
Data used for SI Figure 3 and SI Figure 4:
Global precipitation was sourced from the Global Precipitation Climatology Project (GPCP) V2.3 at a 2.5° resolution available from http://eagle1.umd.edu/GPCP_ICDR/. The GPCP uses a cross-calibration of satellite data inputs and land precipitation gauge analysis (1).
Regional precipitation was sourced from the PERSIANN-CCS-CDR (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks-Cloud Classification System-Climate Data Record) at a 0.04° resolution available from https://chrsdata.eng.uci.edu. The PERSIANN-CCS-CDR clusters cloud patches by geostationary satellite brightness temperatures rather than an individual pixel temperature to rainfall rate (2). Consistency is achieved by incorporating the GPCP monthly product as the CDR (3) . Sea surface temperatures and surface winds were sourced from the National Centers for Environmental Prediction (NCEP) / National Center for Atmospheric Research (NCAR) Climate Data Assimilation System (CDAS)/Reanalysis at an approximate 2° resolution available from https://www.cpc.ncep.noaa.gov/products/wesley/reanalysis.html (4). Topography (in supplementary information and figures) was sourced from ETOPO5 5x5 minute Navy database giving topography and bathymetry on a 5 minute by 5 minute grid available from http://iridl.ldeo.columbia.edu/SOURCES/.WORLDBATH/.dataset_documentation.html.



SI Figure 5: Comparison of food prices to IPC levels in Malawi. Data is derived from FAO GIEWS Food Price Monitoring and Analysis database and FAO Food Balance Sheets.

Price data used in this analysis are from the FAO's GIEWS Food Price Monitoring and Analysis (FPMA) database, which tracks monthly prices at the crop and market level, as in Anderson et al. (2021) (5). We use US-dollar-equivalent prices normalized to the 2015 average with monthly missing values filled via linear interpolation. The data for maize, rice, wheat, cassava/gari, millet, and sorghum is combined into a country-level index using the relative caloric dependence of the population according to the FAO Food Balance Sheets for each crop, averaged over the 2000-2013 time period, and the crop's caloric content according to NutVal 4.1. Price data is then

sub-sampled to match the reporting month of the IPC level in each year. We chose the national level as the appropriate unit of analysis because market coverage in space is relatively sparse and prices between markets tend to move together in time.


rCSI
IPC mean
IPC max
March 2010 - March 2011
April 2013 - Oct 2013
April 2016 - April 2017
0
5
10
15
1
2
3
4
1
2
3
4

SI Figure 6: Comparison between the Reduced Coping Strategy Index (rCSI) (6) (left panel) and Integrated Food Security Phase Classification (IPC) levels (mean IPC, center panel; maximum IPC, right panel) for Malawi in (top row) 2010-2011, (middle row) 2013, and (bottom row) 2016-2017. The figure displays spatial patterns of IPC severity measured as either the average IPC level or the maximum IPC value that occurred during the collection period of the Living Standards Measurement Survey (LSMS) (7) data. The rCSI was computed per Maxwell (2008), in which universal weights were applied to data obtained from the LSMS questions regarding household strategies for coping with food insecurity. Data from the available Malawi LSMS surveys was used for this comparison, which occurred in 2010, 2013, and 2016 (8–10). Note that IPC levels are population-level values mapped evenly over the administrative and livelihood zones that they represent, while the rCSI data is derived from household surveys and plotted as point data with a random 0.05 degree offset for visibility.

SI Table 6a. Population estimates of people in Granger-filtered data whose food security was significantly affected by flooding from gridded 2015 data. Estimates from WorldPop 2020 data are 5,671,657 and 0.1202 for 20% of total people and proportion of population, respectively.

Population	WorldPop 2015 (11)	LandScan 2015 (12)	Global Human Settlement 2015 (13)
Number (20% of total)	4,816,208	4,579,114	4,858,068
Proportion	0.1220	0.1171	0.1219

SI Table 6b. Statistics of population estimates of people in Granger-filtered data whose food security was significantly affected by flooding from gridded 2015 data. Confidence intervals were calculated by modeling each population variable as a t-distribution with 2 degrees of freedom.

Population	Mean	Variance	Standard error	95% confidence interval lower bound	95% confidence interval upper bound
Number (20% of total)	4,751,130	15,086,795,394.67	70,914.96	4,446,007.55	5,056,252.45
Proportion	0.1203	5.264E-06	0.0013	0.1146	0.1260

References:

1. R. F. Adler, *et al.*, The Global Precipitation Climatology Project (GPCP) monthly analysis (New Version 2.3) and a review of 2017 global precipitation. *Atmosphere (Basel)* **9** (2018).
2. Y. Hong, K.-L. Hsu, "Precipitation Estimation from Remotely Sensed Imagery Using an Artificial Neural Network Cloud Classification System."
3. H. Ashouri, *et al.*, PERSIANN-CDR: Daily precipitation climate data record from multisatellite observations for hydrological and climate studies. *Bull Am Meteorol Soc* **96**, 69–83 (2015).
4. R. Kistler, *et al.*, "The NCEP-NCAR 50-Year Reanalysis: Monthly Means CD-ROM and Documentation."
5. W. Anderson, *et al.*, Violent conflict exacerbated drought-related food insecurity between 2009 and 2019 in sub-Saharan Africa. *Nature Food* **2**, 603–615 (2021).
6. D. Maxwell, R. Caldwell, B. Bell, "The Coping Strategies Index Field Methods Manual Second Edition" (2008).
7. M. E. Grosh, P. Glewwe, World Bank., Designing household survey questionnaires for developing countries : lessons from 15 years of the living standards measurement study (2000) (July 11, 2022).
8. Malawi - Third Integrated Household Survey 2010-2011 (August 1, 2022).
9. Malawi - Fourth Integrated Household Survey 2016-2017 (August 1, 2022).
10. Malawi - Integrated Household Panel Survey 2010-2013 (Short-Term Panel, 204 EAs) (August 1, 2022).
11. A. J. Tatem, WorldPop, open data for spatial demography. *Scientific Data 2017 4:1* **4**, 1–4 (2017).
12. LandScan2000: A new global population geography (Book) | OSTI.GOV (August 1, 2022).
13. M. Pesaresi, *et al.*, A global human settlement layer from optical HR/VHR RS data: Concept and first results. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* **6**, 2102–2131 (2013).