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Climate change impacts on floods in West Africa: new insight from two large-scale hydrological models

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Supplementary materials

Table S1: Summary of the selected study sites used in the analysis, including gauge station code (ID), longitude (Lon), latitude (Lat), catchment area (Area), mean annual catchment-averaged rainfall (Prec), mean annual streamflow (Qmean), and the period of available streamflow data (Data Period).

ID	Lon (°)	Lat (°)	Area (KM^2)	Data Period (Start-End)	Qmean ($m^3.s^{-1}$)	Prec (mm)	PET (mm)
ADHI_114	-5.36	9.31	9810.2	1975-1991	27.65	1271.67	1319.89
ADHI_121	-5.53	8.76	14633.27	1960-1991	57.02	1265.67	1287.13
ADHI_123	-6.25	7.83	12606.96	1954-1998	49.93	1423.35	1173.41
ADHI_131	-4.52	7.04	21143.49	1955-1996	42.26	1179.15	1157.89
ADHI_144	-3.52	7.57	5004.22	1983-1996	6.71	1158.69	1157.89
ADHI_163	-7.22	8.54	5834.5	1970-2000	30.35	1642.29	1221.86
ADHI_172	-2.75	9.17	122229.52	1979-2002	100.79	887.91	1641.97
ADHI_179	-3.19	6.02	6758.91	1962-1983	36.17	1409.27	1106.24
ADHI_180	-7.56	4.91	26781.75	1970-1989	437.45	2076.12	1131.26
ADHI_183	-7.46	5.88	1236.75	1955-1993	24.57	2044.13	1107.35
ADHI_187	3.25	10.98	8396.5	1952-1992	22.37	1065.6	1442.32
ADHI_198	2.72	8.25	9618.89	1951-1993	30.56	1100.8	1297.25
ADHI_270	-13.19	11.8	9766.68	1970-1991	192.21	1762.11	1542.78
ADHI_276	-14.21	11.93	20713.14	1977-1990	264.71	1743	1571.14
ADHI_304	-4.11	15.39	578.87	1975-1994	122.92	374.73	1966.94
ADHI_315	5.83	9.12	65549.04	1987-2016	521.72	1090.68	1659.23
ADHI_316	6.75	6.19	143117.05	1981-2017	5226.81	626.97	1923.99
ADHI_319	4.83	9.17	111839.23	1986-2018	1722.56	539.64	1953.54
ADHI_320	4.25	11.52	37221.54	1980-2018	114.78	586.52	2233.63
ADHI_321	7.2	7.98	66428.25	1980-2018	3602.19	1294.96	1536.01
ADHI_324	12.77	9.38	100389.39	1980-2017	1006.14	1197.13	1528.78
ADHI_325	9.34	7.25	17820.29	1980-2017	703.82	2078.88	1122.91
ADHI_332	-15.5	16.52	302.25	1950-1990	579.39	285.87	1931.82
ADHI_372	0.81	10.92	6475.24	1960-1988	7.16	958.77	1637.1
ADHI_390	1.3	7.8	10069.2	1954-1992	50.47	1247.35	1266.93
ADHI_394	1.53	7.02	20749.21	1951-1999	95.89	1245.33	1250.37
ADHI_507	-5.5	8.11	24242.58	1962-1997	94.25	1284.99	1252.63
ADHI_510	-4.36	7.45	16122.37	1954-1997	44.72	1178.96	1157.57
ADHI_511	-3.48	6.12	75803.17	1955-2004	187.28	1185.93	1277.24
ADHI_515	2.65	11.23	8131.51	1953-2017	24.34	1087.24	1447.95
ADHI_519	-1.38	9.53	102484.55	1962-2007	181.01	888.48	1663.82
ADHI_531	-13.57	10.3	16006.71	1955-1984	1499.92	2126.42	1508.34
ADHI_548	-11.38	12.52	8262.07	1950-1995	85.56	1315.05	1541.42
ADHI_550	1.43	13.85	7348.71	1980-2016	40.3	547.95	2196
ADHI_560	-13.25	15.65	69663.94	1950-1989	614.99	800.18	1800.63
ADHI_571	0.47	10.3	37623.74	1953-1992	117.73	996.57	1600.43
ADHI_585	-4.71	6.64	24866.56	1955-1999	45.66	1204.86	1152
ADHI_587	-3.51	7.45	58025.87	1956-2004	162.26	1153.58	1319.31
ADHI_592	-6.69	6.79	6948.84	1961-2004	11.61	1500.81	1078.15
ADHI_595	-2.23	8.28	133940.44	1954-2007	214.5	926.56	1577.85
ADHI_596	-9.16	11.37	68147.41	1952-1989	1054.13	1810.65	1484.28

ADHI_597	-8.76	10.12	6937.52	1980-2017	81.21	1840.33	1338.14
ADHI_605	-3.44	12.75	15877.68	1955-2005	12.66	993.16	1627.6
ADHI_607	-13.73	13.47	42141.85	1953-2003	542.39	1206.21	1627.25
ADHI_612	-13.38	13.34	33109.69	1970-2001	122.33	1188.81	1623.95
ADHI_613	-13.62	13.2	6372.01	1970-2000	27.84	1411.17	1638.61
ADHI_617	2.27	9.2	10273.23	1961-2013	48.66	1173.79	1368.26
ADHI_639	2.33	7.12	8402.14	1952-2011	24.35	1101.6	1228.71
ADHI_640	8.53	7.75	60246.53	1955-2016	3281.82	1278.58	1543.05
ADHI_649	-9.7	10.62	12881.7	1950-2017	204.43	1921.63	1443.09
ADHI_650	-8.68	10.62	22102.66	1954-2017	227.37	1699.26	1354.95
ADHI_651	-10.59	11.24	6392.22	1955-2017	79.15	1697.52	1509.9
ADHI_678	-7.67	10.8	8516.7	1971-1992	47.16	1478.21	1346.71
ADHI_692	-0.58	16.93	82977.88	1954-1992	1133.81	797.87	1765.98
ADHI_1183	-6.22	10.63	9274.38	1976-1993	35.01	1337.19	1320.88
ADHI_1269	-0.88	7.98	6543.46	1998-2007	43.16	1236	1172.11
ADHI_1400	9.95	11.42	9862.53	1963-1982	83.73	1088.03	1829.79
ADHI_1401	9.61	10.93	7993.19	1964-1998	79.95	1122.69	1811.64

Table S2: Land use distribution across different catchments in the study area. The table shows the proportion of each land use type (Forest, Urban, Crop, Irrigated Crops, Grass, Shrub, Sparse, and Bare) within the catchments identified by their unique IDs. Each value represents the proportion (percentage) of the respective land use type within a given catchment.

ID	Forest	Urban	Crop	Crop Irrig	Grass	Shrub	Sparse	Bare
ADHI_114	0.06	0	0.46	0	0	0.48	0	0
ADHI_121	0.27	0	0.29	0	0	0.44	0	0
ADHI_123	0.83	0	0.11	0	0	0.06	0	0
ADHI_131	0.74	0	0.17	0	0	0.09	0	0
ADHI_144	0.49	0	0.49	0	0	0.02	0	0
ADHI_163	0.96	0	0.01	0	0	0.03	0	0
ADHI_172	0.05	0	0.78	0.01	0.02	0.14	0	0
ADHI_179	0.27	0.01	0.72	0	0	0	0	0
ADHI_180	0.31	0	0.67	0	0	0	0	0
ADHI_183	0.56	0	0.44	0	0	0	0	0
ADHI_187	0.33	0	0.39	0	0	0.27	0	0
ADHI_198	0.52	0	0.25	0	0	0.23	0	0
ADHI_270	0.76	0	0.17	0	0	0.07	0	0
ADHI_276	0.74	0	0.14	0	0	0.12	0	0
ADHI_304	0.02	0	0.04	0.03	0.25	0.37	0.26	0.07
ADHI_315	0.05	0	0.74	0	0	0.2	0	0
ADHI_316	0.09	0	0.41	0.01	0.11	0.08	0.05	0.25
ADHI_319	0.14	0	0.38	0.01	0.09	0.11	0.03	0.25
ADHI_320	0	0	0.62	0.02	0.21	0	0.12	0.03
ADHI_321	0.33	0	0.51	0	0.01	0.13	0	0
ADHI_324	0.37	0	0.48	0.01	0	0.14	0	0
ADHI_325	0.83	0	0.09	0	0.04	0.03	0	0
ADHI_332	0.39	0	0.02	0	0.58	0.01	0	0
ADHI_372	0.02	0	0.8	0	0	0.17	0	0
ADHI_390	0.7	0	0.23	0	0	0.07	0	0

ADHI_394	0.62	0	0.33	0	0	0.04	0	0
ADHI_507	0.58	0	0.18	0	0	0.24	0	0
ADHI_510	0.8	0	0.08	0	0	0.11	0	0
ADHI_511	0.43	0	0.44	0	0	0.13	0	0
ADHI_515	0.32	0	0.54	0	0	0.14	0	0
ADHI_519	0.05	0	0.74	0	0.09	0.11	0	0
ADHI_531	0.5	0	0.44	0	0	0.05	0	0
ADHI_548	0.78	0	0.01	0	0	0.2	0	0
ADHI_550	0	0	0.21	0.01	0.69	0.01	0.05	0.03
ADHI_560	0.08	0	0.38	0.02	0.23	0.2	0.04	0.06
ADHI_571	0.11	0	0.49	0	0	0.39	0	0
ADHI_585	0.63	0	0.29	0	0	0.07	0	0
ADHI_587	0.56	0	0.23	0	0	0.21	0	0
ADHI_592	0.1	0.01	0.87	0	0	0.02	0	0
ADHI_595	0.19	0	0.58	0.01	0.01	0.21	0	0
ADHI_596	0.75	0	0.15	0	0	0.09	0	0
ADHI_597	0.96	0	0.01	0	0	0.03	0	0
ADHI_605	0.02	0	0.93	0.01	0	0.05	0	0
ADHI_607	0.43	0	0.09	0	0	0.48	0	0
ADHI_612	0.39	0	0.09	0	0	0.52	0	0
ADHI_613	0.71	0	0.07	0	0	0.21	0	0
ADHI_617	0.61	0	0.21	0	0	0.18	0	0
ADHI_639	0.41	0	0.55	0	0	0.04	0	0
ADHI_640	0.3	0	0.57	0.01	0.01	0.11	0	0
ADHI_649	0.91	0	0.07	0	0	0.02	0	0
ADHI_650	0.92	0	0.01	0	0	0.07	0	0
ADHI_651	0.72	0	0.16	0	0	0.11	0	0
ADHI_678	0.76	0	0.1	0	0	0.14	0	0
ADHI_692	0.1	0	0.45	0.03	0.19	0.12	0.04	0.08
ADHI_1183	0.19	0	0.4	0	0	0.4	0	0
ADHI_1269	0.71	0.01	0.28	0	0	0.01	0	0
ADHI_1400	0.07	0	0.8	0	0	0.13	0	0
ADHI_1401	0.1	0	0.75	0	0	0.15	0	0

Table S3: Mean relative change in 2-year and 20-year flood events for the near-term (2031-2060) and long-term (2071-2100) futures, compared to the historical reference period (1985-2014), from both LISFLOOD and HMF-WA hydrological model's simulations for the near-term (2031-2060) and long-term (2071-2100), under SSP2-4.5 and SSP5-8.5.

HydroModel	**SSP**	**2031-2060**		**2071-2100**	
		Q2	**Q20**	**Q2**	**Q20**
LISFLOOD	SSP2-45	27 %	23 %	20 %	21 %
	SSP5-85	34 %	34 %	31 %	43 %
HMF-WA	SSP2-45	15 %	21 %	18 %	30 %
	SSP5-85	29 %	34 %	35 %	40 %

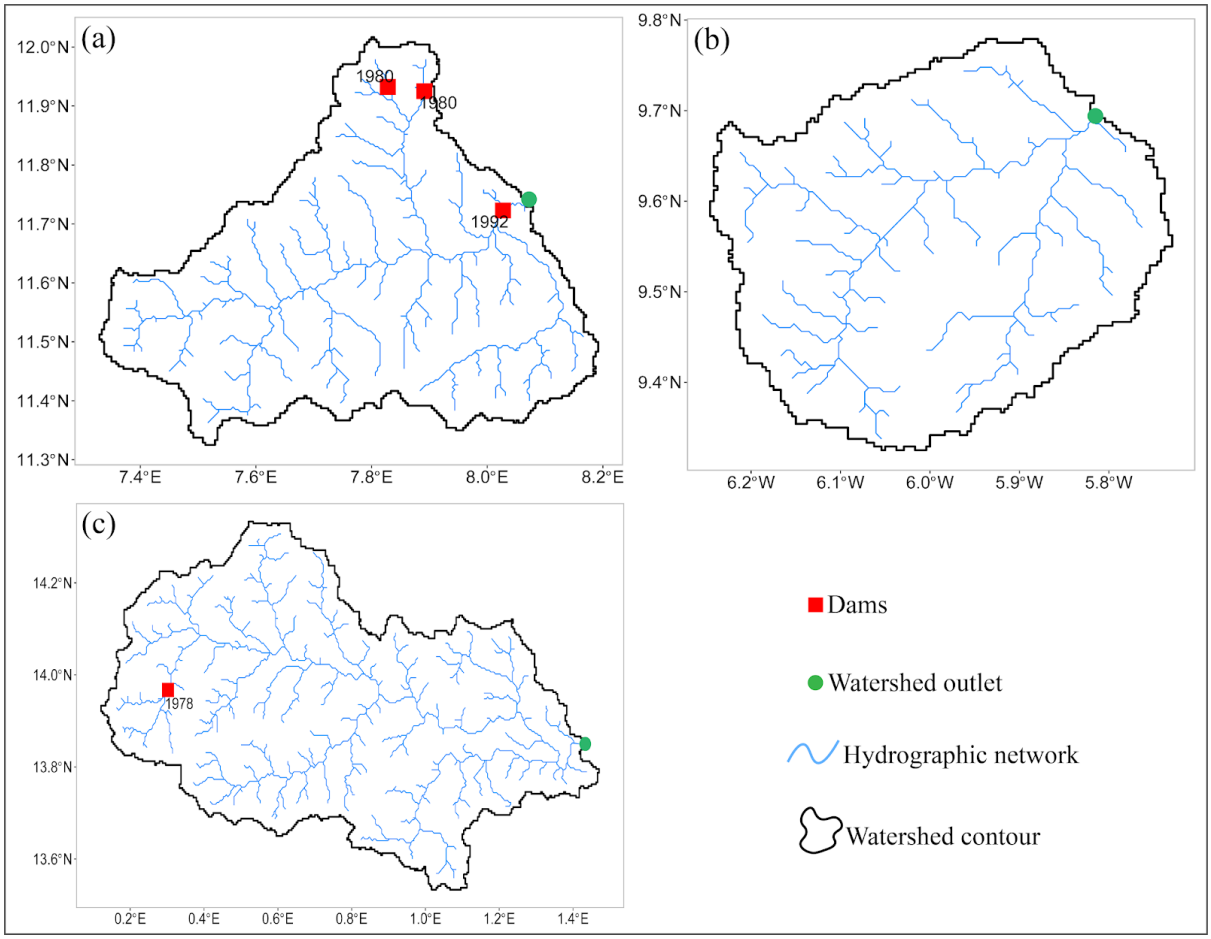

Figure S1: Illustration of the process for selecting hydrometric stations based on watershed regulation. Dam locations are derived from the Global Reservoir and Dam Database (GranD; https://www.globaldamwatch.org/grand/), and hydrographic network data are sourced from the HydroSHEDS database (https://www.hydrosheds.org/products/hydrorivers). Red and green points represent dams and watershed outlets, respectively; blue lines depict the hydrographic network, and black polygons outline watershed contours. Panel (a) shows a dam located near the watershed outlet, leading to station exclusion due to a high probability of influence. In panel (b), the absence of dams within the watershed results in station selection. In panel (c), the dam is positioned far from the watershed outlet, leading to station selection as the probability of influence is low.

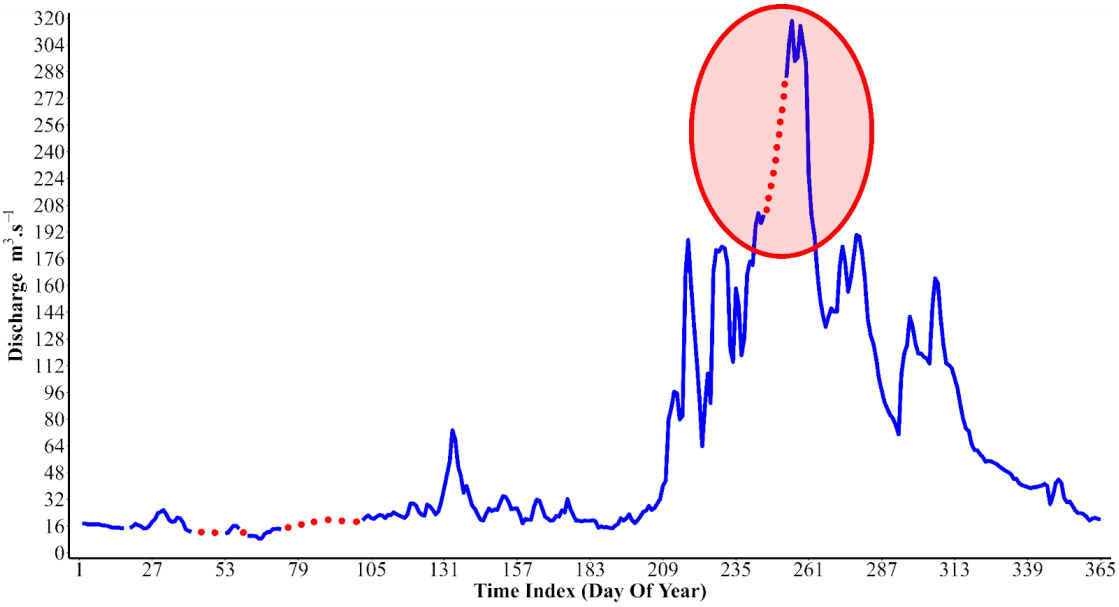

Figure S2: Illustration showing the handling of missing data in an annual hydrograph of daily discharge measurements. A significant portion of data, particularly around the peak discharge period, is missing (highlighted by the red circle). Such a year is excluded from the analysis to ensure the accuracy of the annual peak flood sampling.

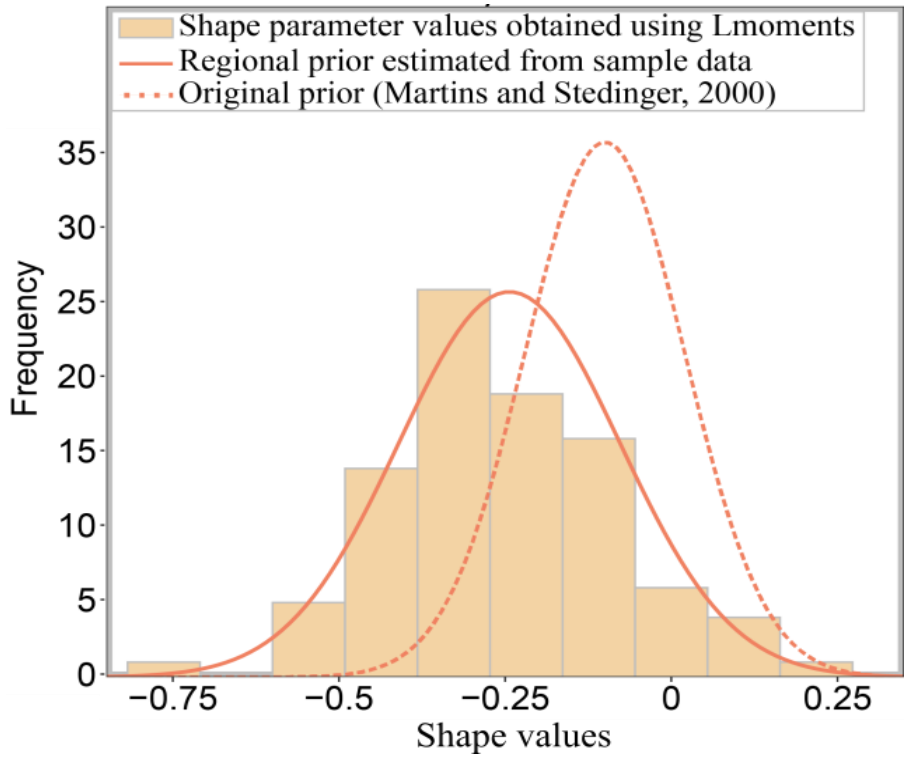

Figure S3: Histogram of shape parameter values of the GEV distribution fitted with L-moments method to the series of annual maxima from 96 stations with more than 20 years of data, with the Martins and Stedinger (2000) prior distribution (dashed line) and the new regional prior (solid line).

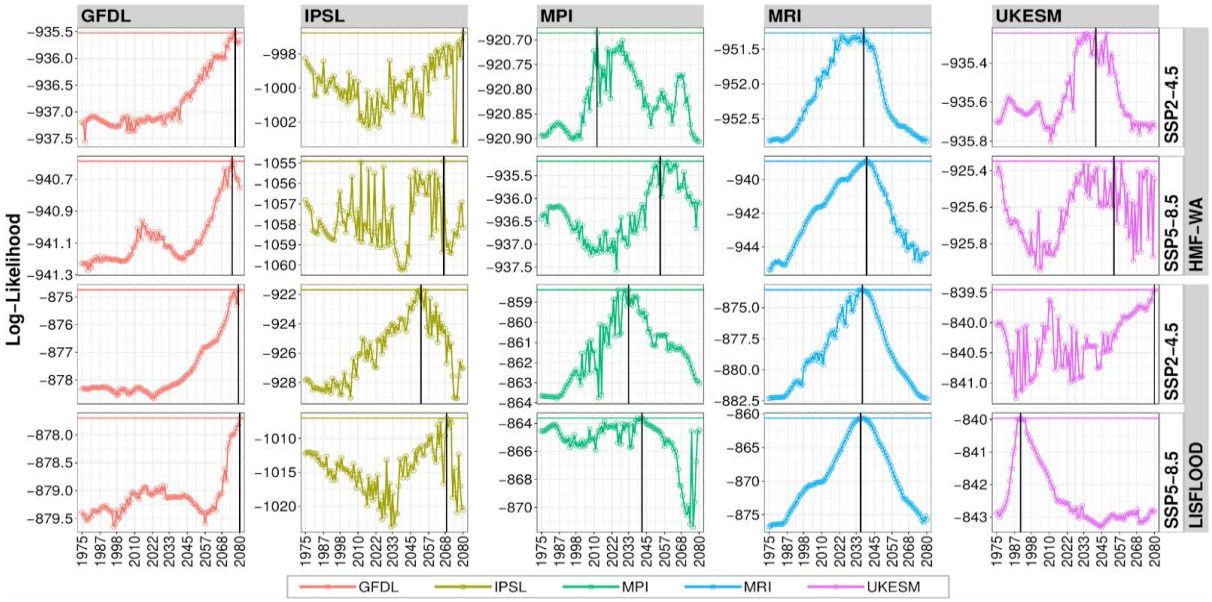

Figure S4: illustration of the selection process of the best time-varying GEV model based on the log-likelihood profiles for the Konkoure at Garafiri station (ADHI-274). The black vertical line marks the start year (t_0) with the higher log-likelihood value, and the horizontal coloured line indicates the maximum log-likelihood value, specific to each CMIP6 model (GFDL, IPSL, MPI, MRI, and UKESM) under SSP2-4.5 and SSP5-8.5 Scenarios.

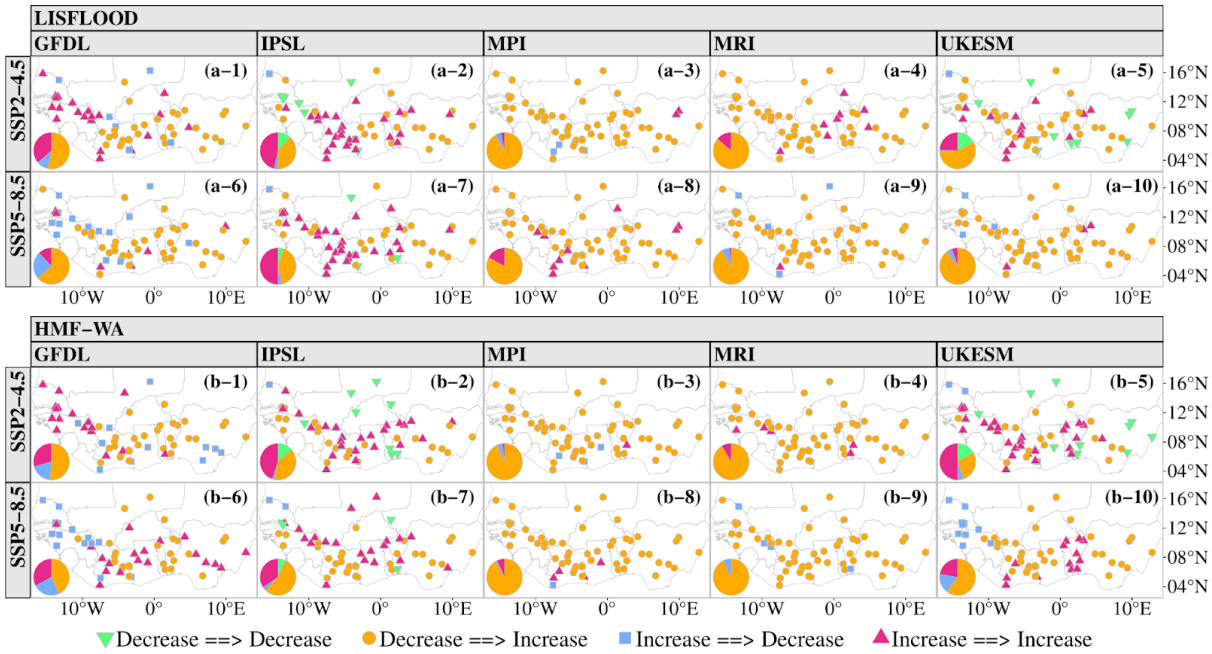

Figure S5: Spatial distribution of flood trend direction derived from the non-stationary GEV3 model, based on annual maximum flood (AMF) series simulated by two hydrological models (LISFLOOD and HMF-WA), forced with five CMIP6 GCMs (GFDL, IPSL, MPI, MRI, UKESM) under SSP2-4.5 and SSP5-8.5 scenarios. The green downward triangles represent decreasing trends before and after the breakpoint, the orange circles indicate decreasing trend before and increasing trend after, the blue regular rectangles show increasing trend before and decreasing trend after, and the red upward rectangles correspond to increasing trends before and after the breakpoint.