



Supplement of

Spatiotemporal analysis of meteorological and hydrological droughts across the Beninese part of the Niger River Basin (West Africa)

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Station data used

Table S1: Rainfall and streamflow stations used

Station Rainfall (P)	Country	Longitude (°)	Latitude (°)	Annual Rainfall [mm]	Rainfall Apr-Oct [mm]
Alfakoara (P1)	Benin	3.07	11.45	908	901
Banikoara (P2)	Benin	2.43	11.3	974	964
Bembereke (P3)	Benin	2.67	10.2	1084	1060
Djougou (P4)	Benin	1.67	9.7	1179	1128
Fada Ngourma (P5)	Burkina Faso	0.37	12.05	800	789
Gaya (P6)	Niger	3.45	11.88	820	817
Ina (P7)	Benin	2.73	9.97	1094	1055
Kalale (P8)	Benin	3.38	10.3	1087	1065
Kandi (P9)	Benin	2.93	11.13	1039	988
Karimama (P10)	Benin	3.18	12.07	696	691
Kouande (P11)	Benin	1.68	10.33	1170	1131
Malanville (P12)	Benin	3.4	11.87	806	797
Natitingou (P13)	Benin	1.38	10.32	1194	1158
Niamey (P14)	Niger	2.1	13.52	530	528
Nikki (P15)	Benin	3.2	9.93	1052	1008
Parakou (P16)	Benin	2.6	9.35	1162	1102
Segbana (P17)	Benin	3.7	10.93	1008	996
Tanguieta (P18)	Benin	1.27	10.62	1030	1002

Streamflow (D)	Country	Longitude (°)	Latitude (°)	Mean streamflow [m ³ /s]
Couberi (D1)	Benin	3.35	11.75	39.4
Yankin (D2)	Benin	2.65	11.15	33.3
Kompongou (D3)	Benin	2.20	11.40	28.7

Illustrating the hydrological and rainfall datasets used

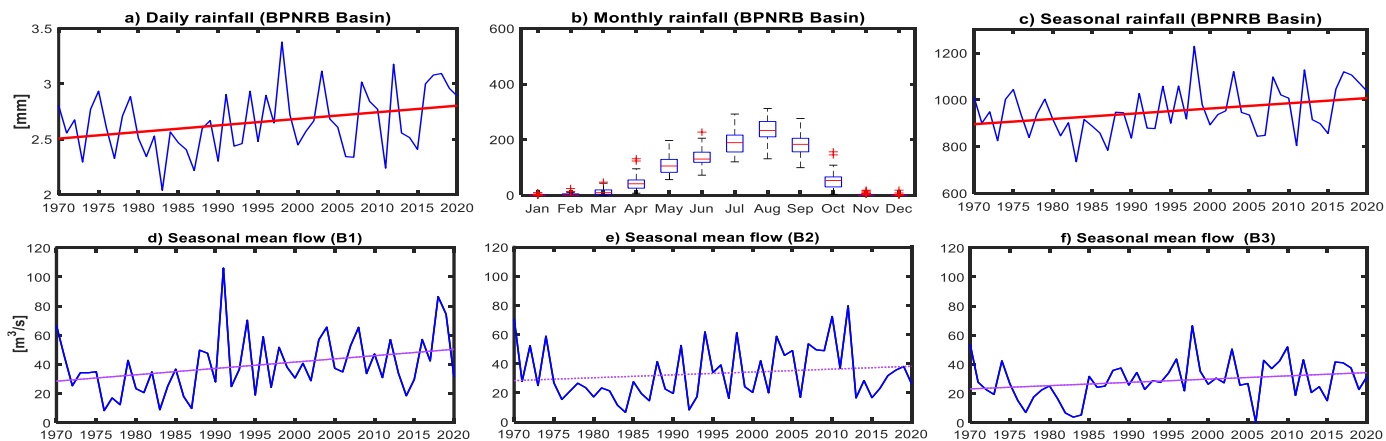


Figure S1: The hydrological and rainfall datasets used a) Daily catchment rainfall, b) Monthly catchment rainfall, c) Seasonal rainfall, d) Seasonal mean flow for hydrological station B1 (Sota

subbasin), e) Seasonal mean flow for hydrological station B2 (Alibori subbasin) and d) Seasonal mean flow for hydrological station B3 (Mekrou subbasin).

Filling of data gaps in the streamflow time series

We used the hydrological model ModHyPMA to fill the data gaps in streamflow observations for the three catchments. ModHyPMA consists of a production function and a transfer function (Afouda A., 2004; Alamous E., 2011). The catchment response is controlled by two parameters, a non-linearity parameter and the basin drying coefficient. The model has been calibrated and validated for both wet and dry periods, demonstrating its ability to accurately distinguish between these two hydrological conditions. For all three catchments, a good model performance has been found with R^2 (coefficient of determination) and NSE (Nash Sutcliff Efficiency) values in the range of 0.56–0.73 and 0.56–0.60, respectively, for the validation periods (Table S2).

Table S2: Performance of the ModHyPMA model for calibration and validation periods.

Catchment	Calibration		Validation			
	Period	R^2	NSE	Period	R^2	NSE
B1	1986-1989	0.78	0.74	2003-2007	0.73	0.56
B2	1984-1987	0.64	0.63	2005-2008	0.66	0.60
B3	1971-1974	0.84	0.83	2007-2010	0.56	0.59

- Temperature data used in the PET calculation

The mean temperature used over the period 1970-2020 was obtained from climate station P9 which is centrally located in the study area (Fig. 1).

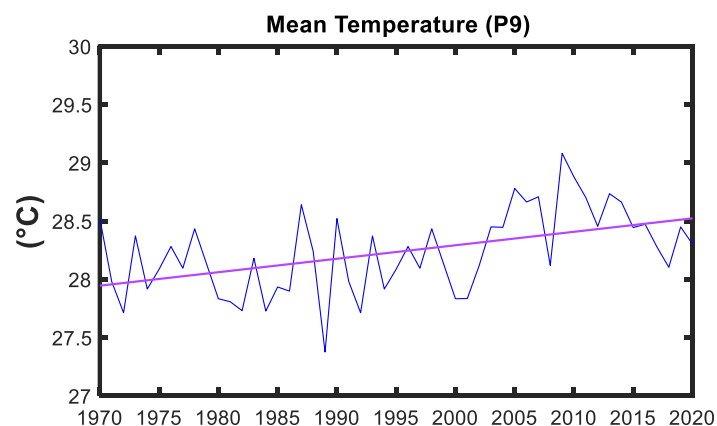


Figure S2: Mean temperature of the rainy season at Kandi station (P9, see Fig. 1) for the period 1970–2020. The linear trend is significant at 5%.

Table S3: Results of the trends test on the SPI, SPEI, CDD and SDI values

Indices	Stations	Tau Value	Sen's slope	P_Value
SPI-3**	Spm over BPNRB	6.11E-02	3.37E-04	2.87E-01
SPI-6*	Spm over BPNRB	9.60E-02	5.22E-04	1.14E-02
SPI-12*	Spm over BPNRB	1.53E-01	7.94E-04	4.81E-03
SPEI-3*	Spm over BPNRB	-1.20E-01	-6.47E-04	2.76E-03
SPEI-6*	Spm over BPNRB	-1.19E-01	-5.77E-04	2.03E-02
SPEI-12**	Spm over BPNRB	-3.60E-04	-7.85E-02	1.02E-01
CDD	Alfakoara**	0.132	0.3333	0.252
	Banikoara**	0.125	0.4000	0.199
	Bembereke**	-0.111	-0.1106	0.255
	Djougou**	0.090	0.3529	0.528
	Fada**	0.015	0.0526	0.900
	Gaya**	-0.106	-0.3571	0.276
	Ina**	-0.074	-0.2083	0.450
	Kalale**	0.117	0.3158	0.232
	Kandi**	0.045	0.1429	0.649
	Karimama**	0.086	0.3846	0.656
	Kouande**	0.027	0.0698	0.789
	Malanville**	-0.140	-0.4444	0.150
	Natitingou**	0.028	0.08	0.776
	Niamey**	-0.113	-0.3182	0.249
	Nikki**	-0.106	-0.3810	0.280
Parakou**	0.008	0.04	0.942	

	Segbana**	0.176	0.6957	0.071
	Tanguieta*	0.292	0.8889	0.0002
CDDinR	Alfakoara**	0.147	0.050	0.129
	Banikoara**	-0.071	0.000	0.461
	Bembereke**	-0.044	0.000	0.652
	Djougou**	0.024	0.000	0.805
	Fada**	0.153	0.050	0.113
	Gaya**	-0.011	0.000	0.915
	Ina**	-0.007	0.000	0.948
	Kalale*	0.201	0.057	0.019
	Kandi**	-0.055	0.000	0.570
	Karimama**	0.166	0.143	0.222
	Kouande**	0.087	0.000	0.368
	Malanville**	-0.135	-0.067	0.043
	Natitingou**	-0.010	0.000	0.921
	Niamey**	-0.005	0.000	0.968
	Nikki**	0.112	0.029	0.322
	Parakou**	0.038	0.000	0.481
	Segbana**	0.033	0.000	0.737
	Tanguieta**	0.120	0.030	0.213
SDI-3	Gbasse*	0.191	0.0016	3.83E-03
	Couberi**	0.130	0.0011	5.03E-02
	Yankin*	0.212	0.0017	3.41E-03
	Kompongou**	0.143	0.0011	8.89E-02
SDI-6	Gbasse*	0.287	0.0024	3.33E-08
	Couberi*	0.214	0.0018	9.55E-04
	Yankin*	0.199	0.0017	8.82E-03
	Kompongou*	0.184	0.0015	3.74E-02
	Gbasse*	0.380	0.0033	2.93E-16

SDI-12	Couberi*	0.306	0.0026	2.20E-05
	Yankin**	0.174	0.0016	7.35E-02
	Kompongou*	0.209	0.0016	1.01E-02

* Significant trend, ** No Significant trend, Spm= Spatial mean