Impact of climate change on rainfall variability in the Blue Nile basin

تأثير التغير المناخى على تقلبات الامطار فى حوض النيل الازرق

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NILE BASIN INITIATIVE
INITIATIVE DU BASSIN DU NIL

Objectives

- The study examined the rainfall in the three seasons separately in addition to the total annual rainfall.
- The study tried to study the rainfall from all aspects as; variability, trend, concentration, normality, and anomaly index.

Types of Data

- The climate data have consisted of mean monthly and mean annual rainfall (MAR) records.
- The chosen study period is from 1950 to 2018 according to the availability of the recorded data for all stations.
- Ten stations covering different parts of the BNB.

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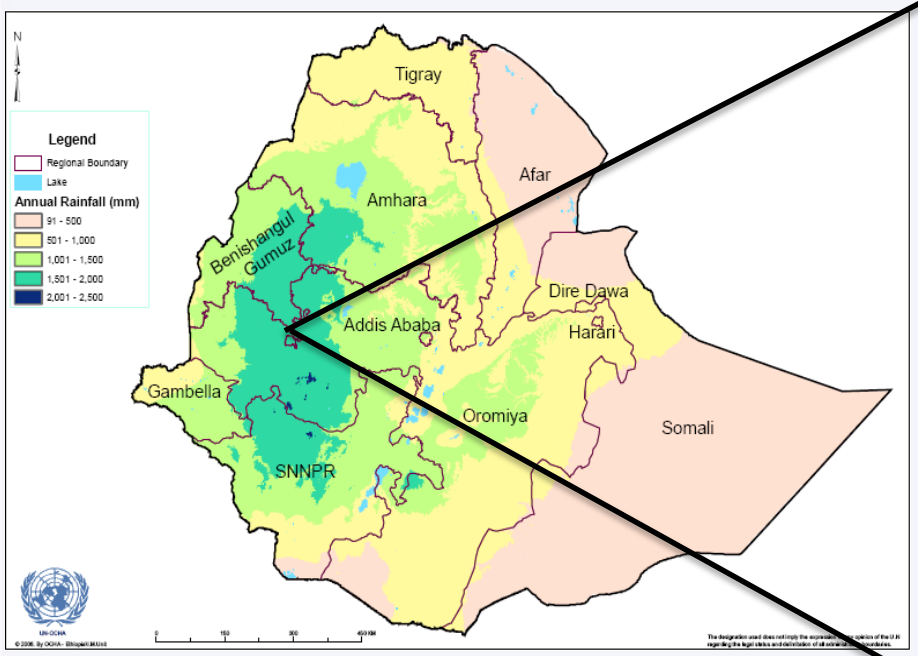
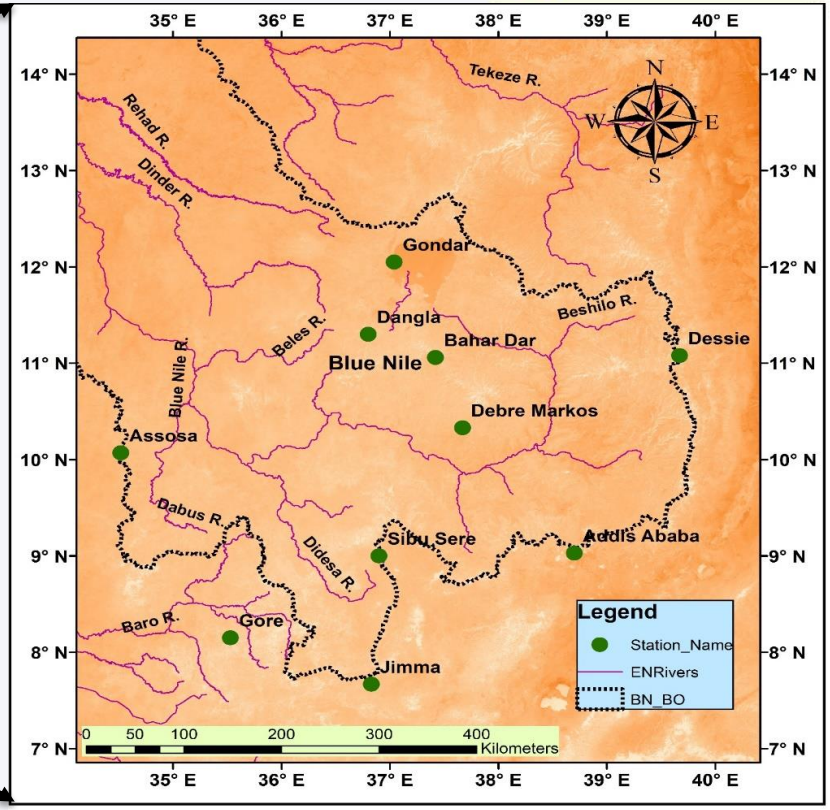
Location of BNB and selected major meteorology stations of the BNB

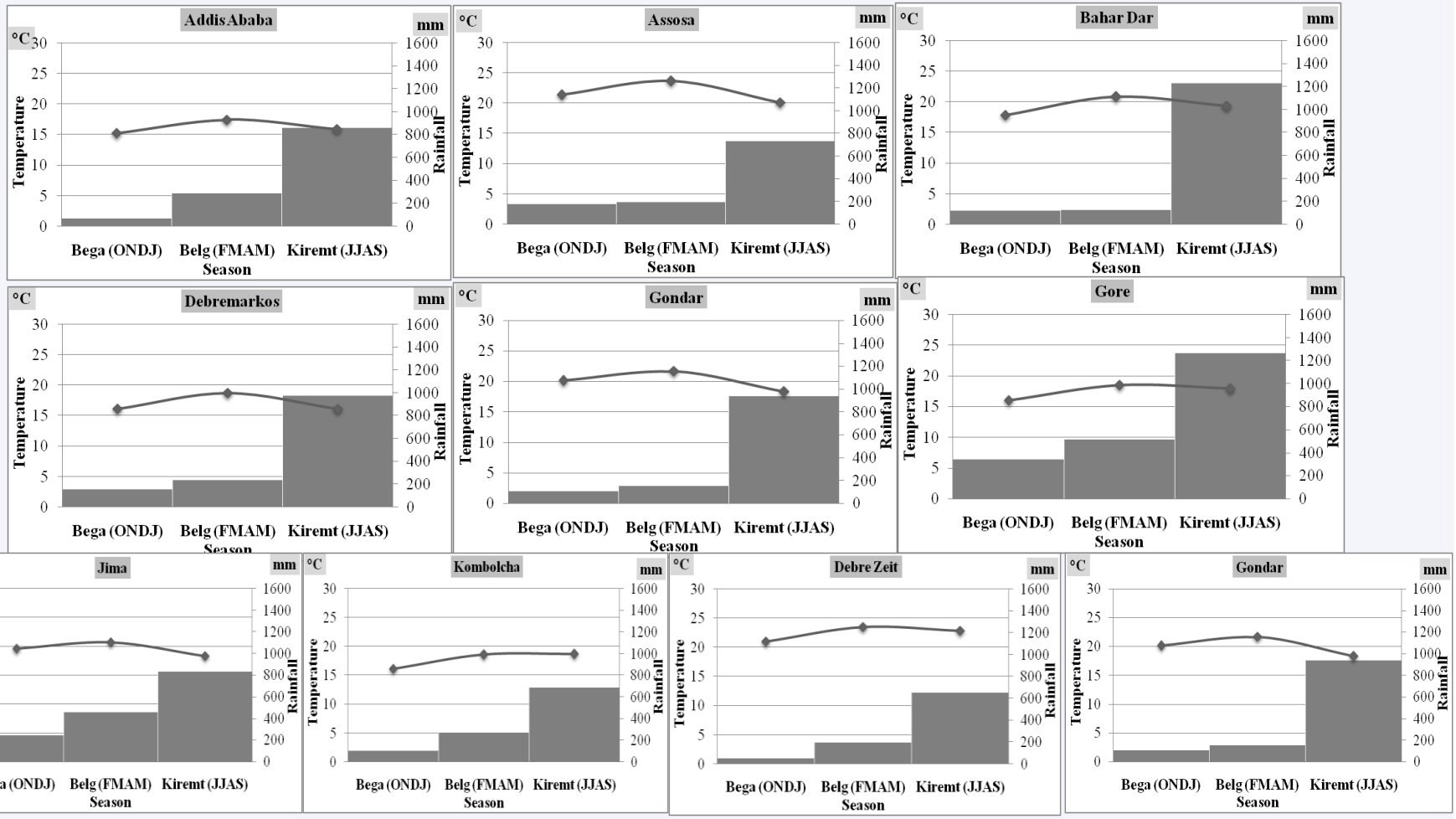




The study area

The study area is the whole of Ethiopia, situated between 3° to 15° N latitude and 33° to 48° E longitude, with a total area of 1.13 million km2. The region has a highly irregular topography, Characterised by the central and northern highlands, and the lowlands of the rift valley plain.

Figure: Temperature and rainfall in the Ethiopian seasons



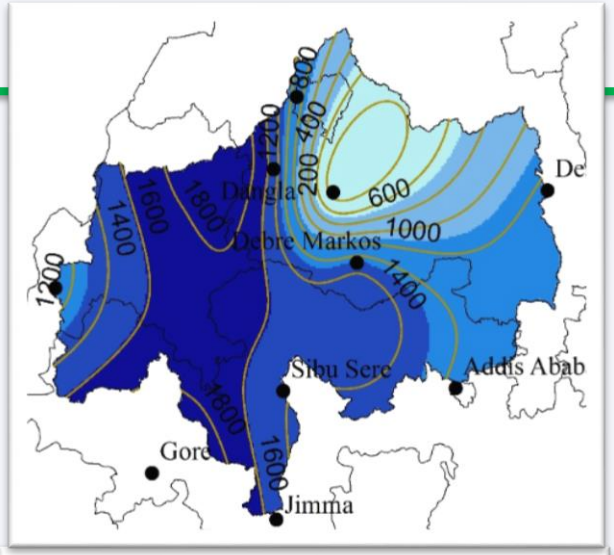
Basic statistics and MK trend analysis of rainfall in the BNB

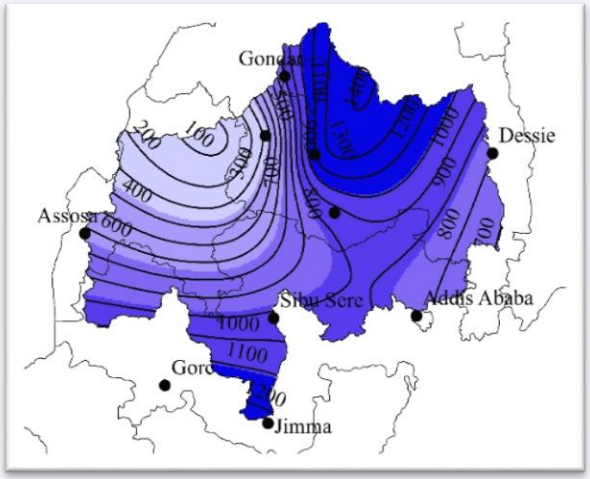
Table 2 Basic statistics and MK trend analysis of rainfall in the BNB (1950–2018).

Month	Min.	Max.	Mean	SD	CV (%)	Skewness/ Kurtosis	MK Test	Sens slope
January	0	55.1	16.0	12.6	78.8	1.2/1.0	−0.26	−0.016
February	0.9	74.9	22.5	15.2	67.6	1.1/1.9	−1.92+	−0.158
March	9.9	143	49.5	24.4	49.3	1.2/2.1	−0.88	−0.130
April	18.7	172.5	77.0	27.8	36.1	0.5/1.0	−1.56	−0.300
May	39.3	179.8	105.5	31.0	29.4	0.2/0.0	−0.02	−0.003
June	84.1	226.3	150.9	29.8	19.7	0.3/-0.4	−2.80**	−0.551
July	164.3	340.6	256.2	33.0	12.9	0.3/0.5	−2.66**	−0.503
August	176.9	357.2	262.0	30.7	11.7	0.5/1.2	−2.91**	−0.424
September	101.5	260.1	166.4	31.5	18.9	0.7/0.6	−4.43***	−0.782
October	22.3	162.5	76.8	32.3	42.0	0.6/-0.2	0.60+	0.102
November	3.8	119.1	27.1	20.1	74.1	2.0/5.9	−1.72+	−0.149
December	0	43	14.9	11.0	73.6	0.9/0.3	−1.91+	−0.134
Annual	975.1	1581.8	1224.7	133.5	10.9	0.6/0.0	−4.38***	−3.226
Bega	59.9	246.3	134.9	44.8	33.2	0.6/-0.1	−1.34	−0.361
Belg	166.4	399.4	254.4	52.7	20.7	0.7/0.9	−2.21*	−0.549
Kiremt	625.6	1077.8	835.4	97.2	11.6	0.6/0.0	−4.13***	−2.215

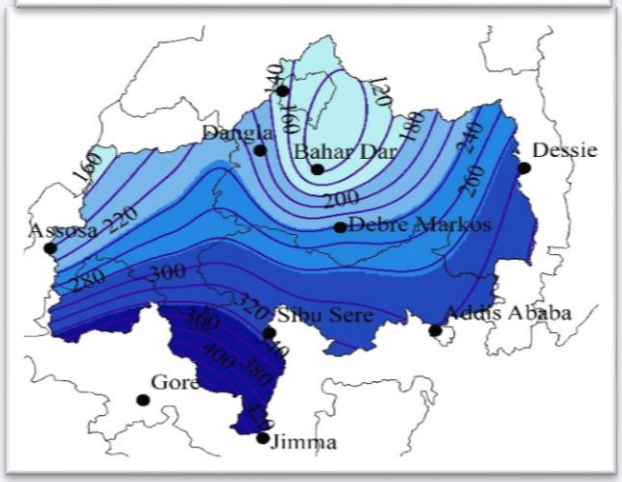
Sig. = the tested significance levels 0.1%, 1%, 5%, and 10% as: *** = 0.1%, level of significance, ** = 1% level of significance, * = 5% level of significance, + = 10% level of significance, and the cells with no superscripts = 10% significance level (non-significant).

Annual rainfall (mm)

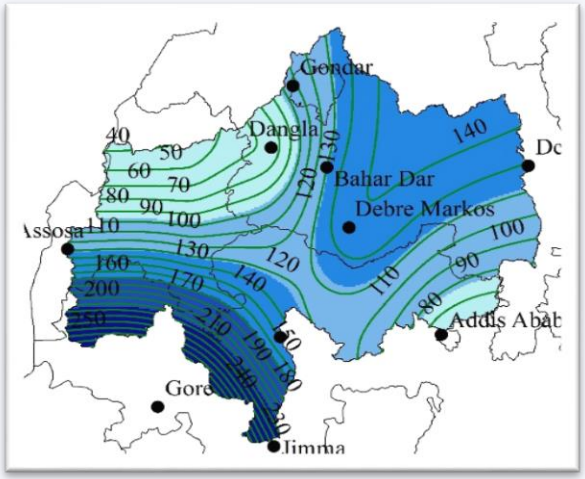




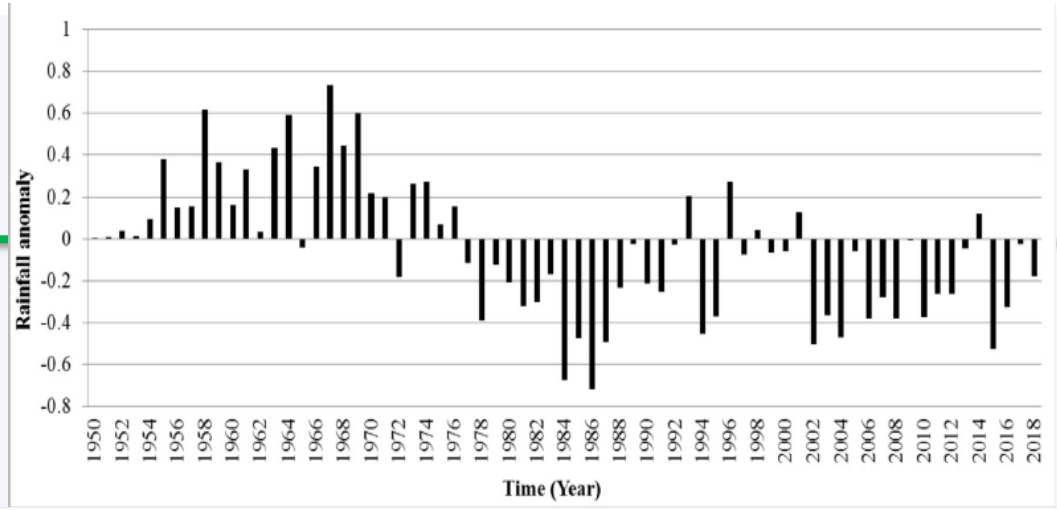
Kiremt season rainfall (mm)



Belg season rainfall (mm)



Bega season rainfall (mm)


Rainfall anomaly
Time (Year)

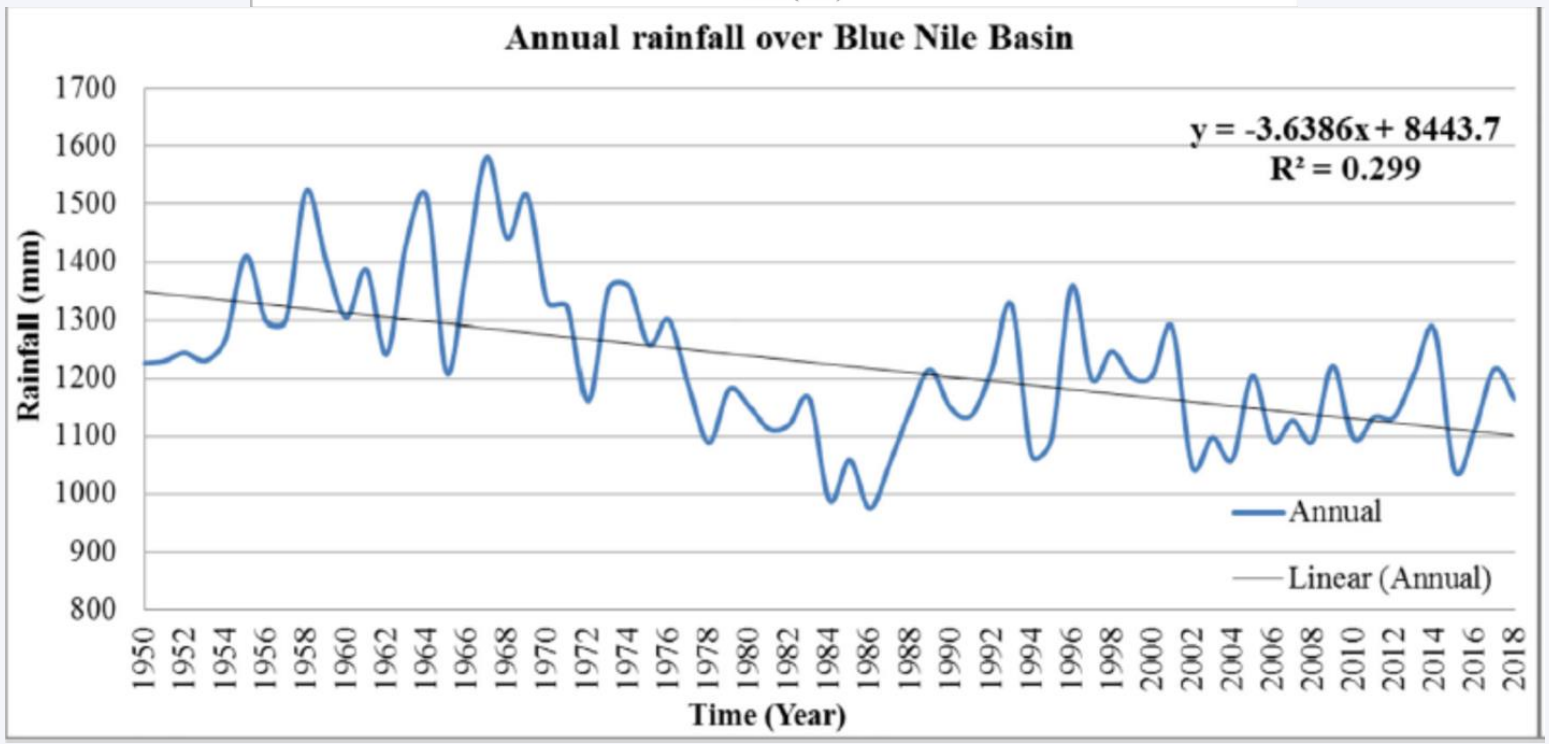

Annual rainfall over Blue Nile Basin
y = -3.6386x + 8443.7
R² = 0.299
Rainfall (mm)
Time (Year)
Annual
Linear (Annual)

Table 5 Independent samples *t*-test result before and after 1960.

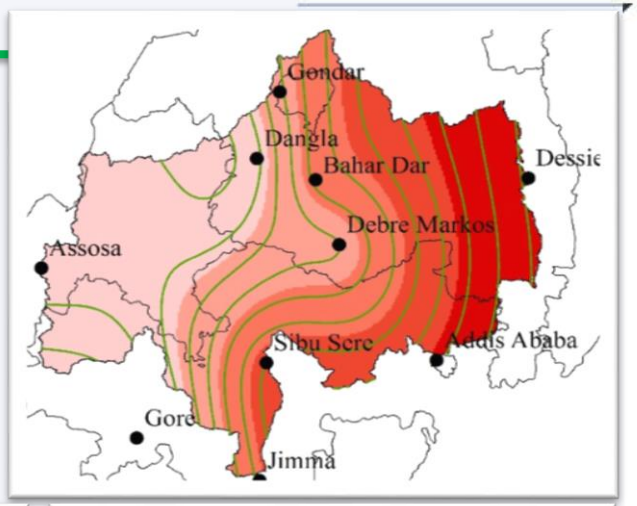
Season	Before 1960 Mean ± SD	After 1960 Mean ± SD	Mean difference	Independent samples *t*-test	P value
Annual	1312.6 ± 94.5	1208.0 ± 133.9	8.0%	2.46	0.016*
Bega	142.0 ± 44.1	133.5 ± 45.2	6.0%	0.57	0.569
Belg	270.6 ± 56.9	251.3 ± 51.8	7.1%	1.12	0.270
Kiremt	900.0 ± 84.8	823.2 ± 95.1	8.5%	2.49	0.015*

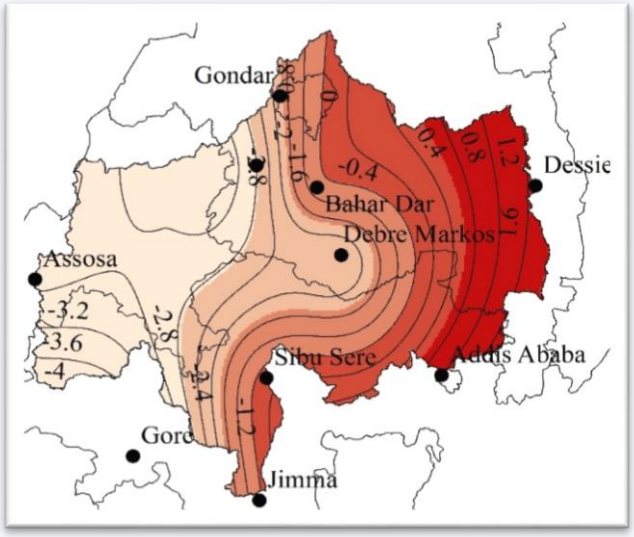
Table 6 Precipitation Concentration Index (PCI) of BNB (1950–2018).

Season	Index	Description	Number of years No.(%)
Annual	≤10	Low precipitation concentration (almost uniform)	0(0)
	11–15	Moderate concentration	62(89.9)
	16–20	High concentration	7(10.1)
	≥21	Very high concentration	0(0)
Mean PCI (1950–2018) = 14.6 (Moderate concentration of Rainfall)			
Bega	≤10	Low precipitation concentration (almost uniform)	39(56.5)
	11–15	Moderate concentration	28(40.6)
	16–20	High concentration	2(2.9)
	≥21	Very high concentration	0(0)
Mean PCI (1950–2018) = 10.8 (Moderate concentration of Rainfall)			
Belg	≤10	Low precipitation concentration (almost uniform)	65(94.2)
	11–15	Moderate concentration	4(5.8)
	16–20	High concentration	0(0)
	≥21	Very high concentration	0(0)
Mean PCI (1950–2018) = 8.5 (Low concentration of Rainfall)			
Kiremt	≤10	Low precipitation concentration (almost uniform)	69(100)
	11–15	Moderate concentration	0(0)
	16–20	High concentration	0(0)
	≥21	Very high concentration	0(0)
Mean PCI (1950–2018) = 6.7 (Low concentration of Rainfall)			

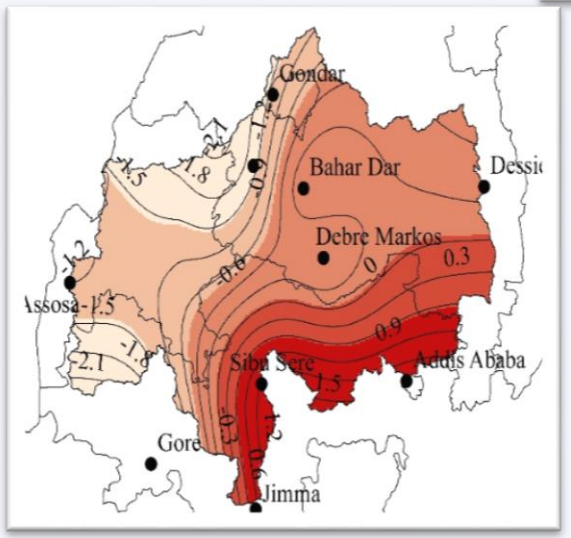
The Mann-Kendall (MK) test

Annual rainfall (mm)

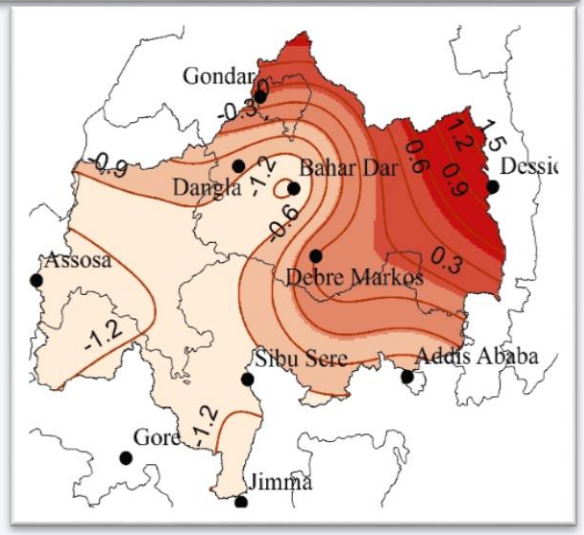




Kiremt season rainfall (mm)



Belg season rainfall (mm)



Bega season rainfall (mm)

Enhancing Nile Cooperation: Key Recommendations for Advancing the Theme of the 7th Nile Basin Development Forum (NBDF)

Foster Inclusive Dialogue and Cooperation: To deepen Nile cooperation and advance the theme of the 7th NBDF, it is crucial to prioritize inclusive dialogue and cooperation among all riparian states.

Enhancing Nile Cooperation: Key Recommendations for Advancing the Theme of the 7th Nile Basin Development Forum (NBDF)

Foster Economic Integration and Benefit Sharing: To deepen cooperation and advance the theme of the 7th NBDF, it is essential to ensure equitable benefit sharing and foster economic integration among the riparian states. The following recommendations can be pursued:

1. Facilitate Trade and Investment: Promote trade and investment opportunities among Nile Basin countries to foster economic integration and shared prosperity. Simplify cross-border trade procedures, remove trade barriers, and establish mechanisms for investment facilitation to encourage economic cooperation and regional development.

2. Develop Joint Infrastructure Projects: Encourage the development of joint infrastructure projects, such as transport networks, energy interconnections, and cross-border connectivity initiatives.

3. Ensure Equitable Benefit Sharing: Establish mechanisms and frameworks for equitable benefit sharing derived from shared water resources and joint infrastructure projects. Implement transparent and fair allocation mechanisms that consider the socio-economic needs and vulnerabilities of all riparian states, ensuring that the benefits are distributed in a just and inclusive manner.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