



RICCAR

Regional Initiative for the Assessment of
Climate Change Impacts on Water Resources and
Socio-Economic Vulnerability in the Arab Region

Extreme climate indices in selected basins (Wadi Diqah, Nahr Al Kabir, Medjerda)



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Arid Zones and Dry Lands (ACSAD)**

objective

- The objective of this study is to provide insights to extreme events over the coming decades due to climate change in three hydrological basins in the Arab region.

Changes in Temperature Indices

- **Warm spell duration indicator** : Annual count of days with at least 6 consecutive days when maximum temperature > 90th percentile
- **Cold spell duration indicator** : Annual count of days with at least 6 consecutive days when minimum temperature < 10th percentile
- **Tropical nights** : Annual count when daily minimum temperature > 20°C
- **Number of hot days** > Annual number of days when $T_{max} > 35^{\circ}\text{C}$
- **Number of very hot days** > Annual number of days when $T_{max} > 40^{\circ}\text{C}$

Changes in Precipitation Indices

- **Consecutive dry days** : Maximum number of consecutive days with precipitation $< 1\text{mm}$
- **Consecutive wet days** : Maximum number of consecutive days with precipitation $\geq 1\text{mm}$
- **Heavy precipitation days** : Annual count of days when precipitation $\geq 10\text{mm}$
- **Very Heavy precipitation days** : Annual count of days when precipitation $\geq 20\text{mm}$
- **Simple daily intensity index** : Annual total precipitation divided by the number of wet days (defined as $\text{PRCP} \geq 1.0\text{mm}$) in the year



Drought index

- **Standardized Precipitation Index (SPI)**

Time Scales :

- ✓ **6-month SPI:** Agricultural drought.
- ✓ **12-month:** hydrological drought.

SPI Classes

SPI Value	SPI Class
2.0 +	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near normal
-1.0 to -1.49	Moderately dry
-1.5 to -1.99	Severely dry
-2 and less	Extremely dry

Study Area



Mejerda basin
Tunisia-Algeria

Nahr el Kabir
Al-Junoubi-
Syria-Lebanon

WADI DAYQAH
SULTANATE OF OMAN

Nahr el Kabir Al-Junoubi

- The Nahr el Kabir Al-Junoubi constitutes the Lebanese Syrian borders
- The total water shed area (within Lebanon and Syria) is about 990 km² of which 295 km² lies in Lebanon



Medjerda River



Basin Area = 22070 km²

Shared between Tunisia and Algeria

Wadi Dayqah basin, Oman



located 60 km southeast of Muscat

Basin area = 1870 km²

The background is a smooth blue gradient, transitioning from a lighter blue at the top to a darker blue at the bottom. On the left side, there is a bright, glowing area that resembles a sun or moon reflecting on water, creating a shimmering effect. The overall appearance is clean and professional.

results

Nahr el Kabir Al-Junoubi

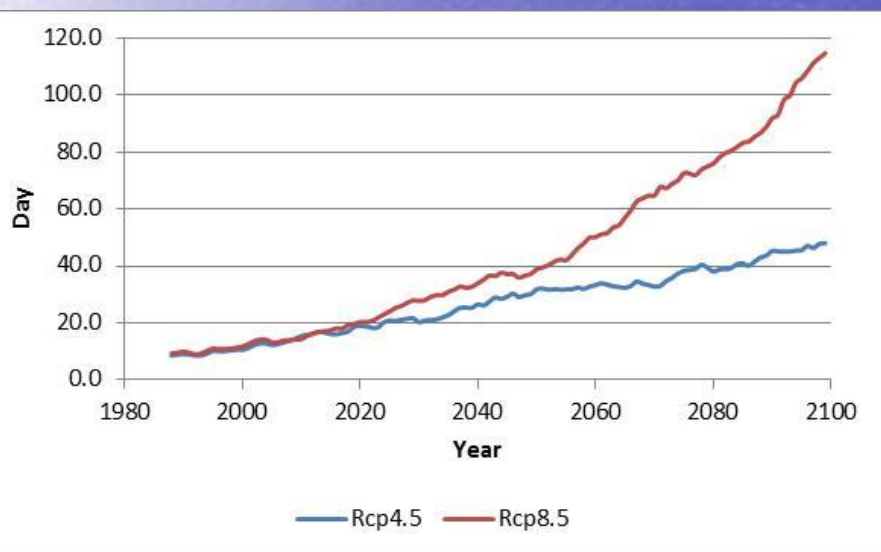


Changes in Temperature Indices

Nahr el Kabir Al-Junoubi basin

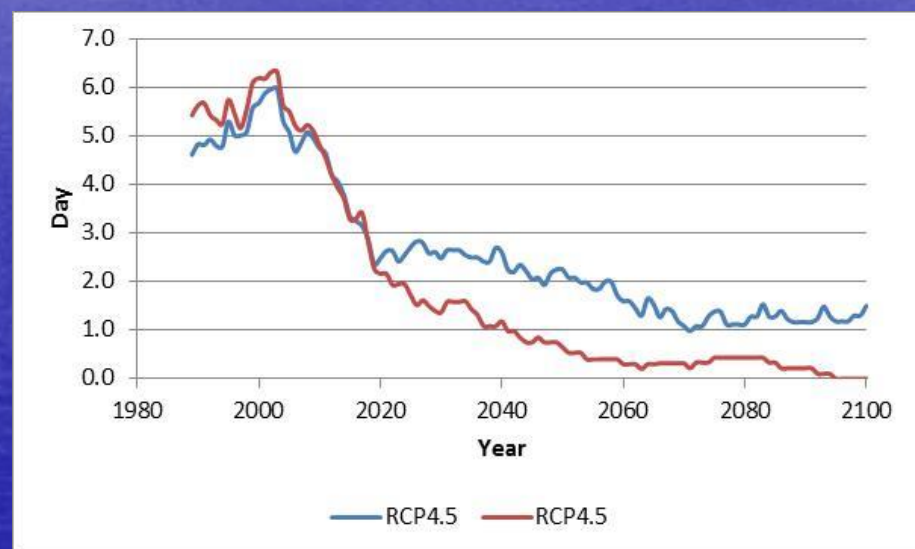
Warm spell duration indicator

Annual count of days with at least 6 consecutive days when maximum temperature > 90th percentile



Cold spell duration indicator

Annual count of days with at least 6 consecutive days when minimum temperature < 10th percentile

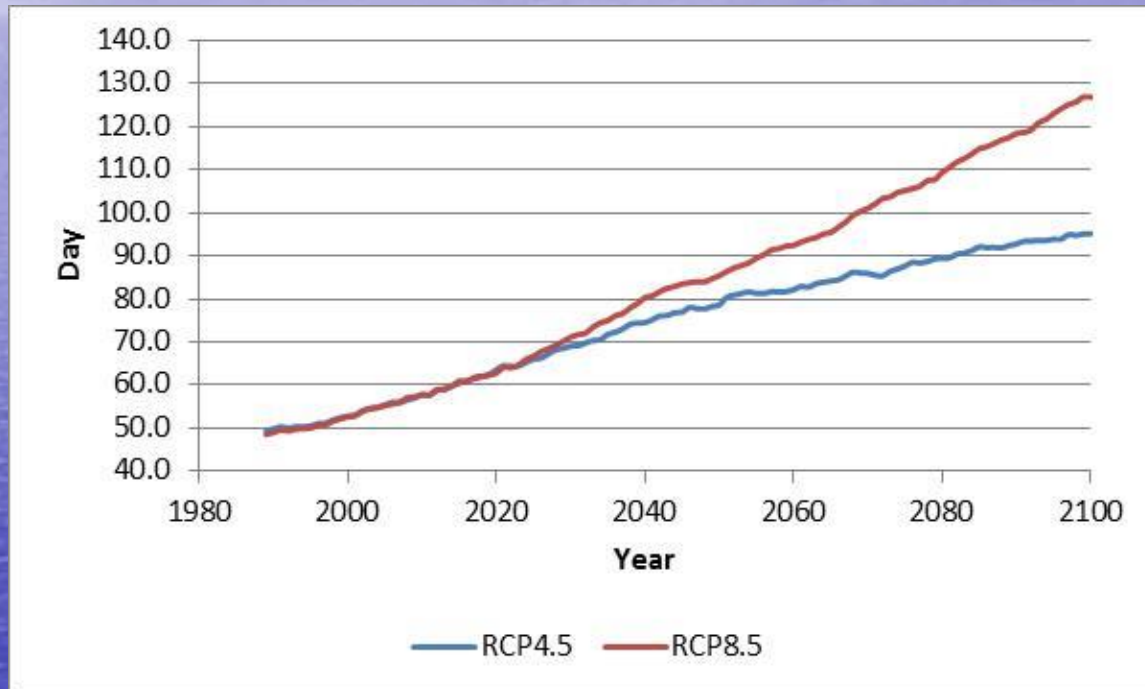


	1986-2005	2046-2065	2081-2100
RCP4.5	10	32	44
RCP8.5	11	44	94

	1986-2005	2046-2065	2081-2100
RCP4.5	5.2	1.9	1.3
RCP8.5	5.7	0.5	0.2

Tropical nights

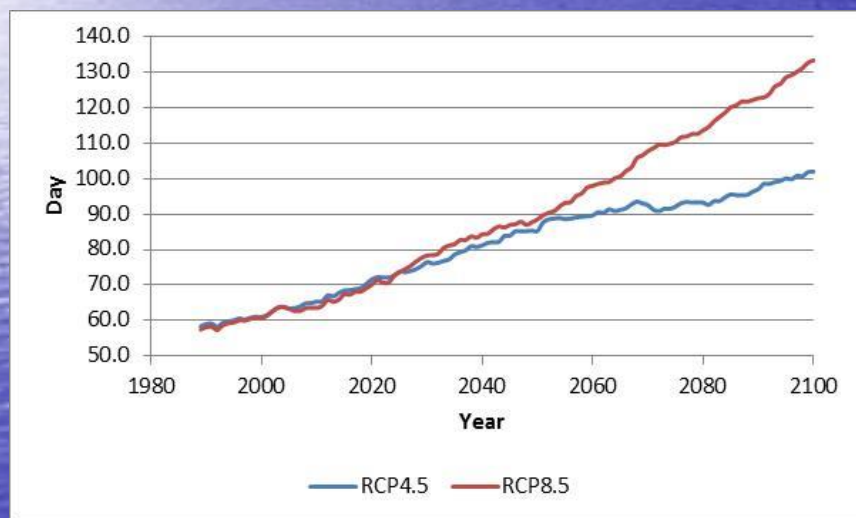
Annual count when daily minimum temperature > 20°C



	1986-2005	2046-2065	2081-2100
RCP4.5	52	81	93
RCP8.5	52	89	119

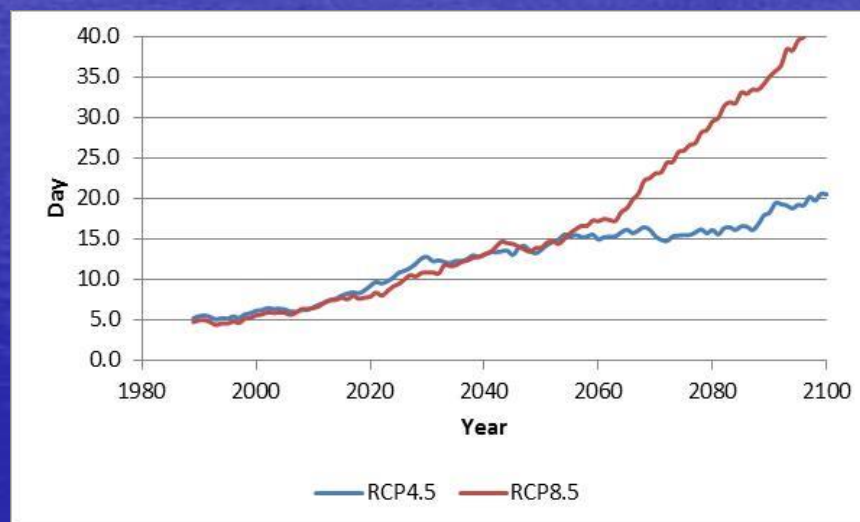
Number of hot days

Annual count when daily maximum temperature $>35^{\circ}\text{C}$



Number of very hot days

Annual count when daily maximum temperature $>40^{\circ}\text{C}$



	1986-2005	2046-2065	2081-2100
RCP4.5	60	88	98
RCP8.5	60	93	124

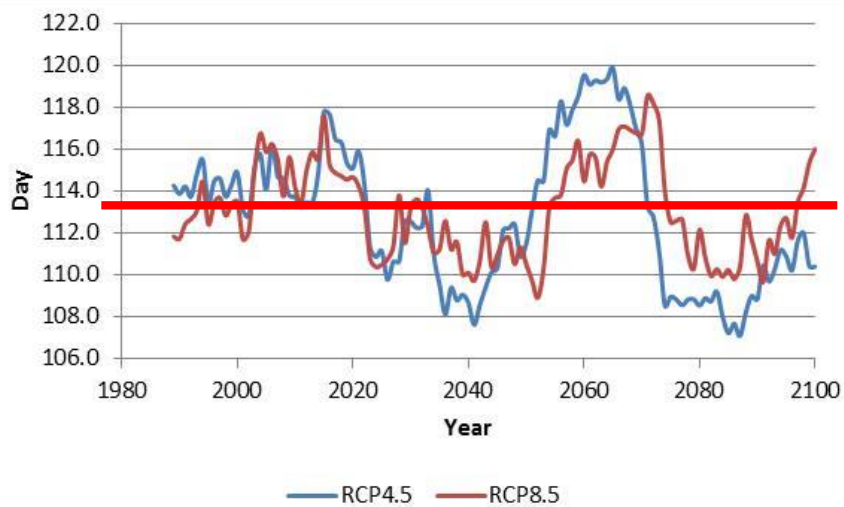
	1986-2005	2046-2065	2081-2100
RCP4.5	5	15	18
RCP8.5	5	16	36



Changes in Precipitation Indices

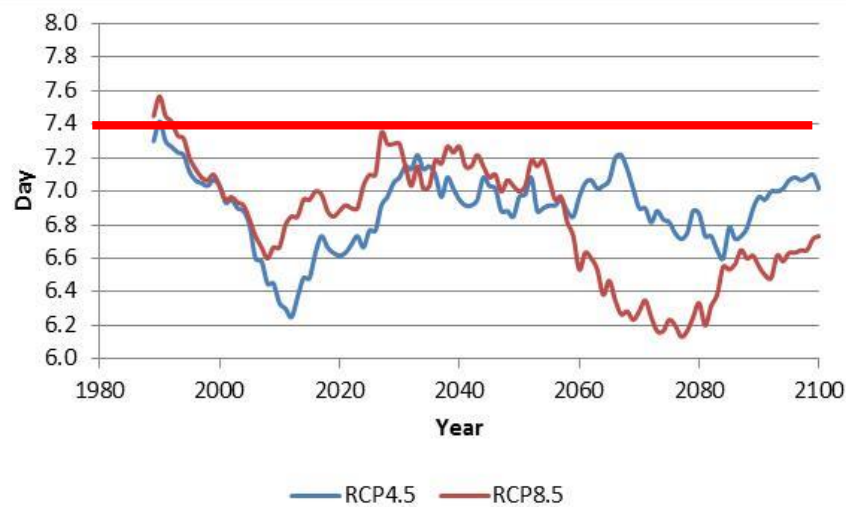
Consecutive dry days

Maximum number of consecutive days with precipitation < 1mm



Consecutive wet days

Maximum number of consecutive days with precipitation ≥ 1 mm



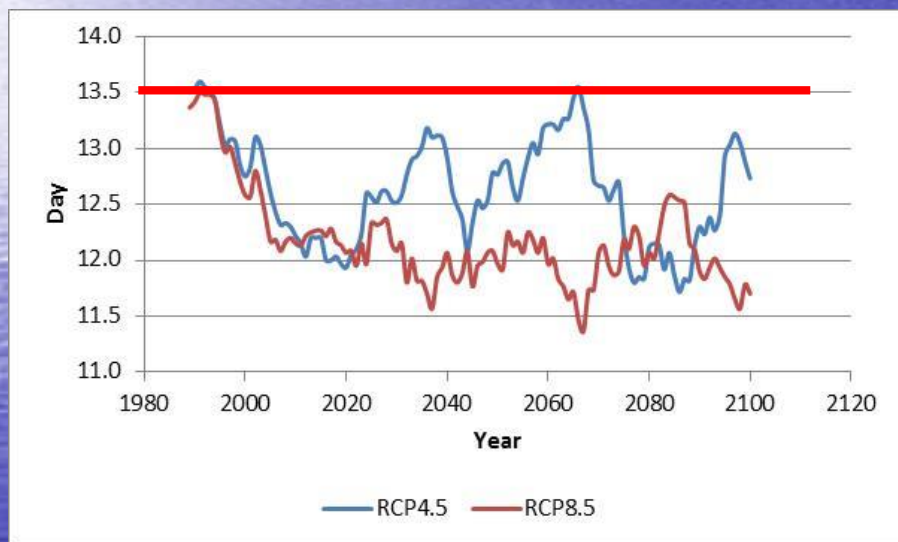
	1986-2005	2046-2065	2081-2100
RCP4.5	114	116	110
RCP8.5	113	113	112

	1986-2005	2046-2065	2081-2100
RCP4.5	7.1	7.0	6.9
RCP8.5	7.2	6.9	6.6

Nahr el Kabir Al-Junoubi basin

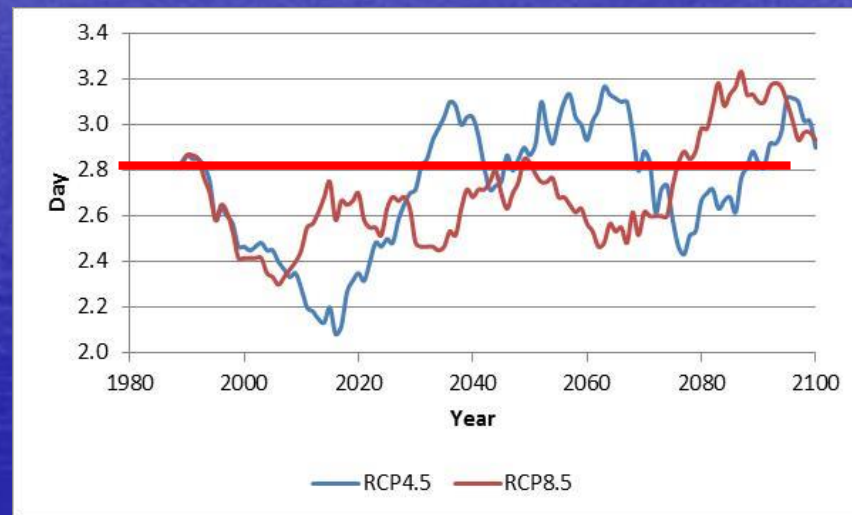
Heavy precipitation days

Annual count of days when precipitation $\geq 10\text{mm}$



Very Heavy precipitation days

Annual count of days when precipitation $\geq 20\text{mm}$

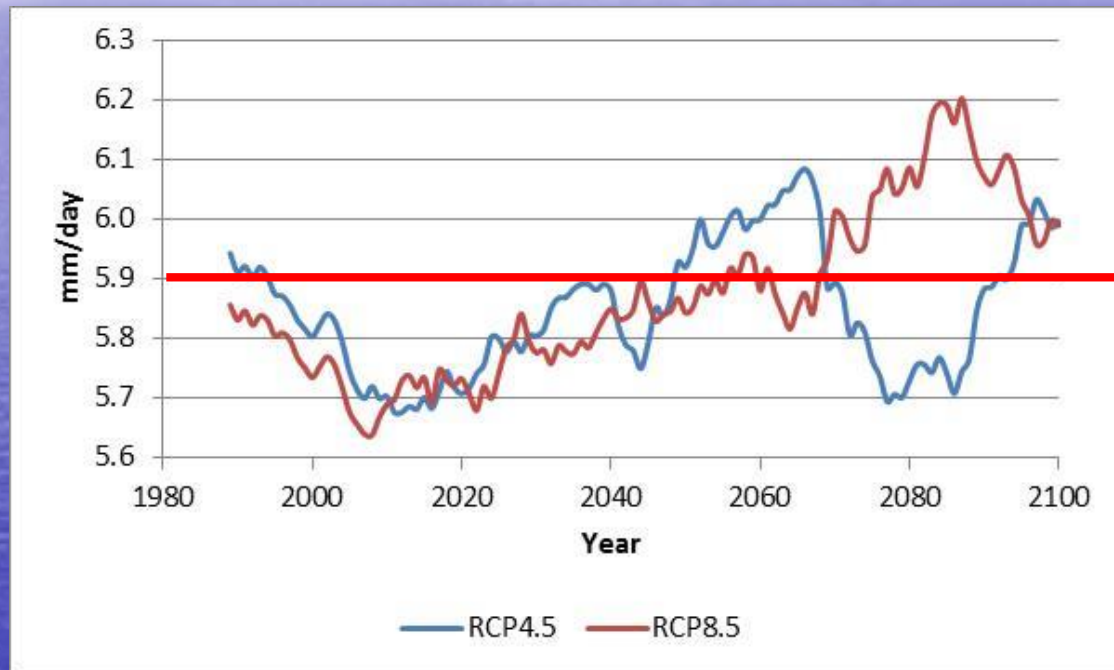


	1986-2005	2046-2065	2081-2100
RCP4.5	13.1	12.9	12.3
RCP8.5	13.0	12.0	12.1

	1986-2005	2046-2065	2081-2100
RCP4.5	2.6	3.0	2.9
RCP8.5	2.6	2.7	3.1

Simple daily intensity index

Annual total precipitation divided by the number of wet days (defined as PRCP \geq 1.0mm) in the year



	1986-2005	2046-2065	2081-2100
RCP4.5	5.9	6.0	5.9
RCP8.5	5.8	5.9	6.1



Changes in drought Indices



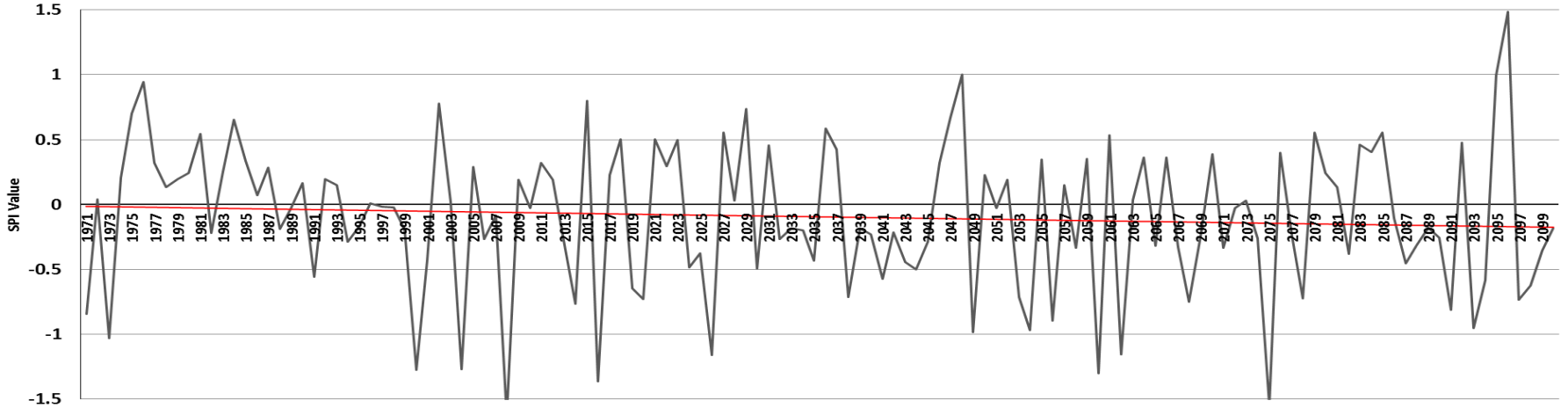
Overall trend of predicted SPI

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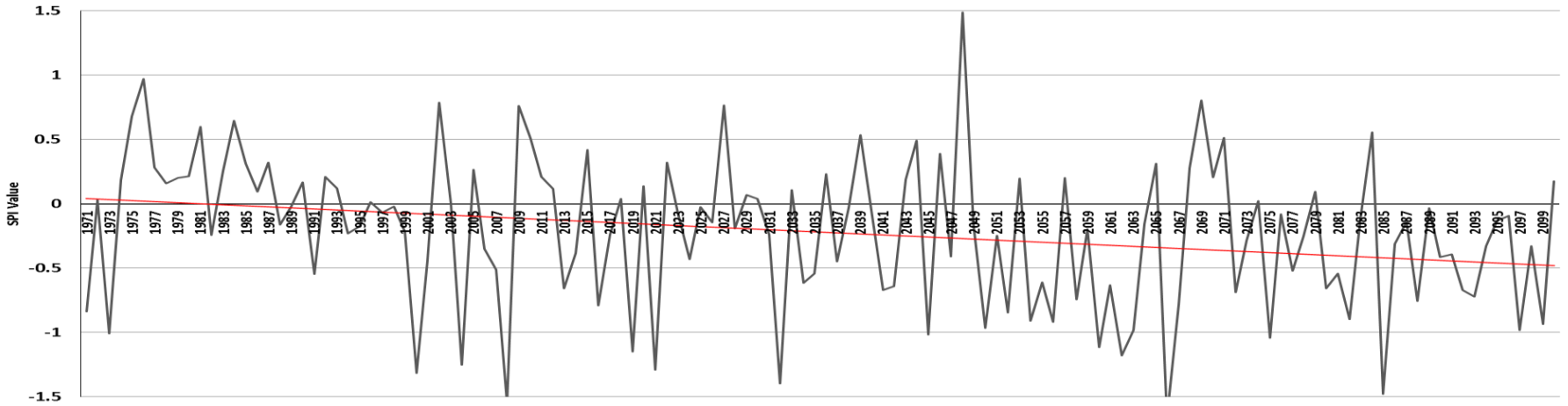
SPI(6 month)

Values_Alkabir Aljonobi_rcp 4.5



SPI(6 month)

Values_Alkabir Aljonobi_rcp 8.5



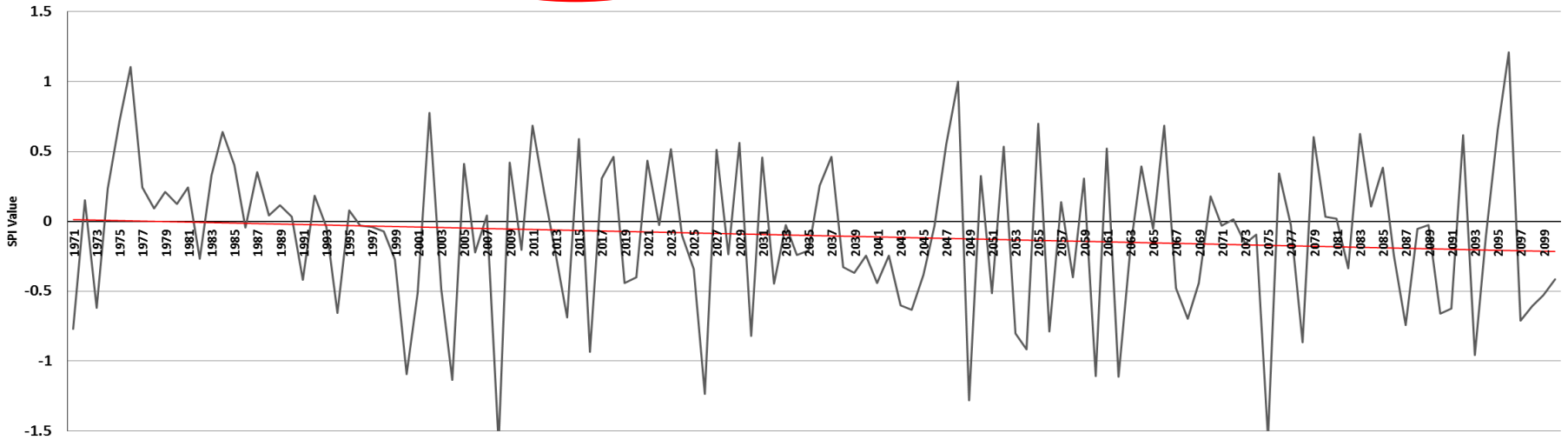


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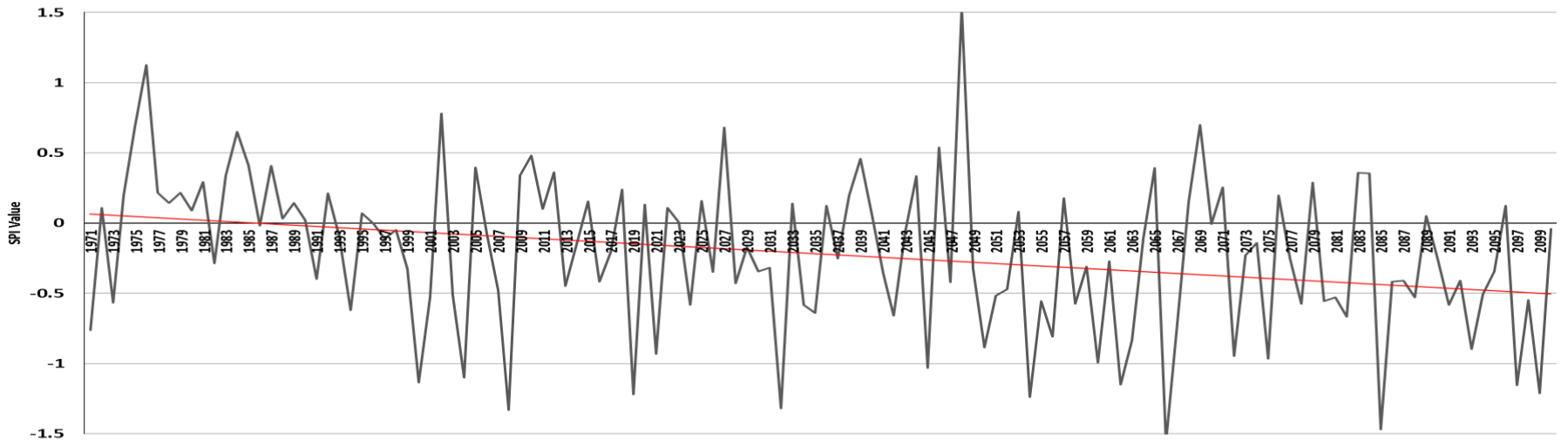
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Socio-Economic Well-being in the Region

Overall trend of predicted SPI

SPI(12 month) Values_Alkabir Aljonobi_rcp 4.5



SPI(12 month) Values_Alkabir Aljonobi_rcp 8.5



The percentage of time with moderate, severe and extreme drought conditions

SPI values 6 moth scale	Drought Condition	Reference period	RCP 4.5		RCP 8.5	
			Mid Century proj	End century proj	Mid Century proj	End century proj
-1 to -1.49	moderate	55%	45%	65%	75%	90%
-1.5 to -2	severe	0	0	0	0	0
<= -2	extreme	0	0	0	0	0
	Total	55%	45%	65%	75%	90%

SPI values 12 moth scale	Drought Condition	Reference period	RCP 4.5		RCP 8.5	
			Mid Century	End century	Mid Century	End century
-1 to -1.49	moderate	60%	55%	65%	75%	80%
-1.5 to -2	severe	0	0	0	0	0
<= -2	extreme	0	0	0	0	0
	Total	60%	55%	65%	75%	80%

Medjerda River Basin



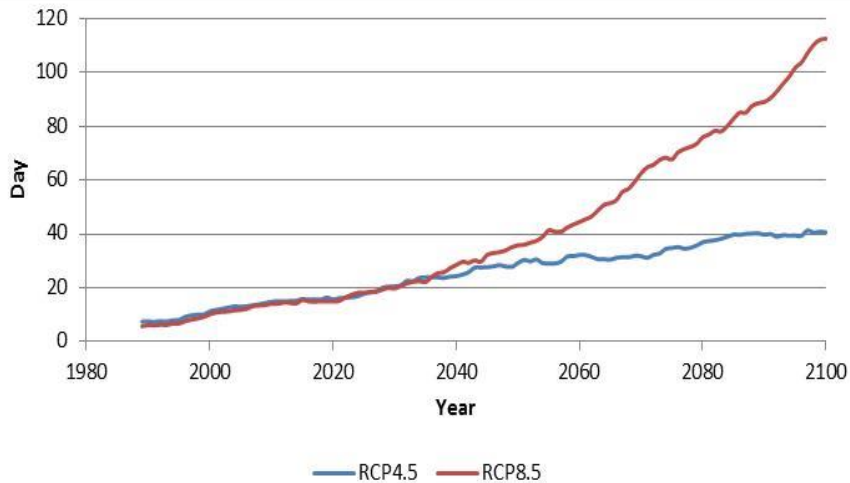


Changes in Temperature Indices

Medjerda River Basin

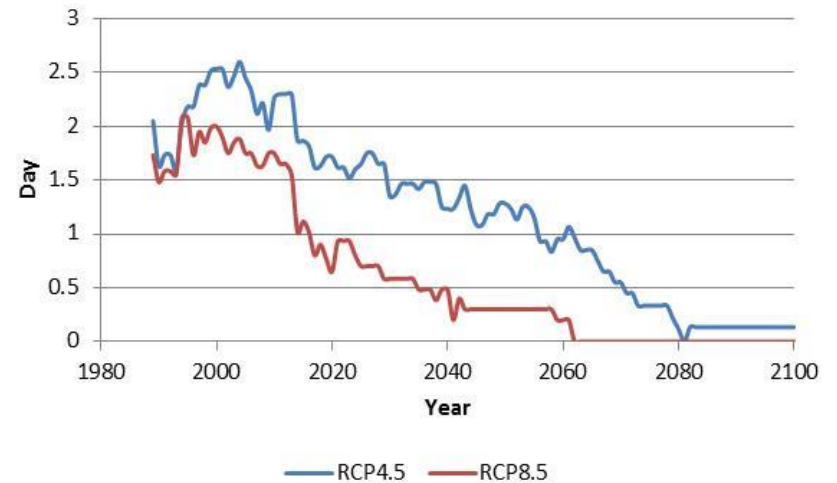
Warm spell duration indicator

Annual count of days with at least 6 consecutive days when maximum temperature > 90th percentile



Cold spell duration indicator

Annual count of days with at least 6 consecutive days when minimum temperature < 10th percentile

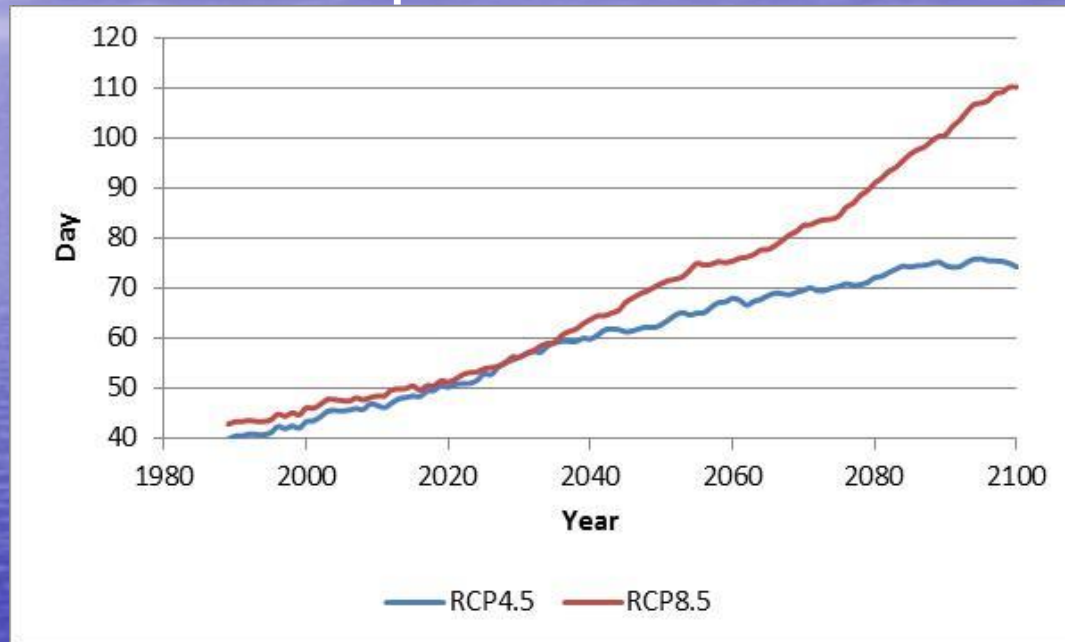


	1986-2005	2046-2065	2081-2100
RCP4.5	10	30	40
RCP8.5	8	40	93

	1986-2005	2046-2065	2081-2100
RCP4.5	2.2	1.1	0.1
RCP8.5	1.8	0.2	0.0

Tropical nights

Annual count when daily minimum temperature > 20°C

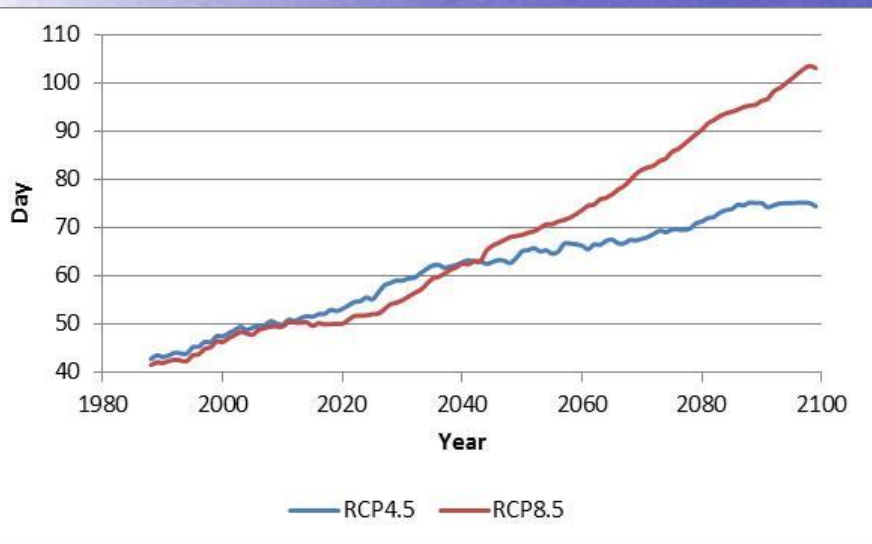


	1986-2005	2046-2065	2081-2100
RCP4.5	42	65	75
RCP8.5	45	73	102

Medjerda River Basin

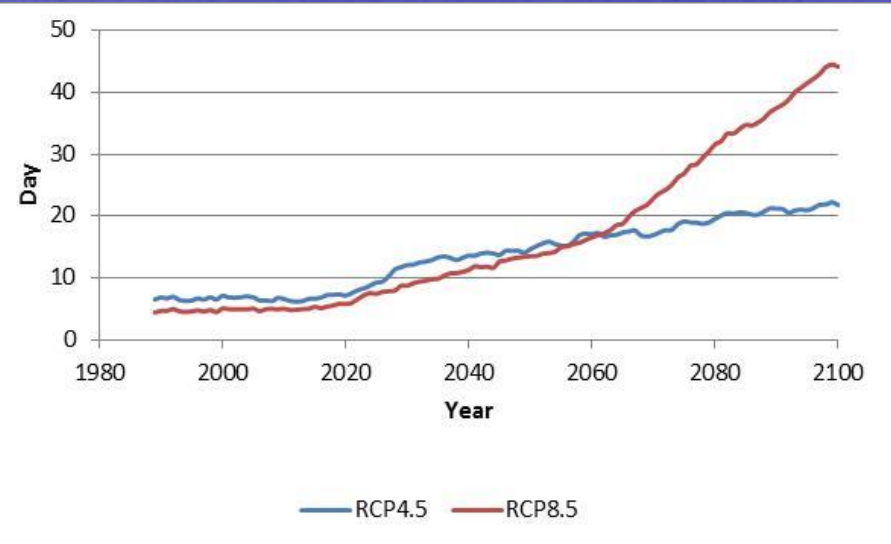
Number of hot days

Annual count when daily maximum temperature $>35^{\circ}\text{C}$



Number of very hot days

Annual count when daily maximum temperature $>40^{\circ}\text{C}$



	1986-2005	2046-2065	2081-2100
RCP4.5	46	65	74
RCP8.5	45	71	97

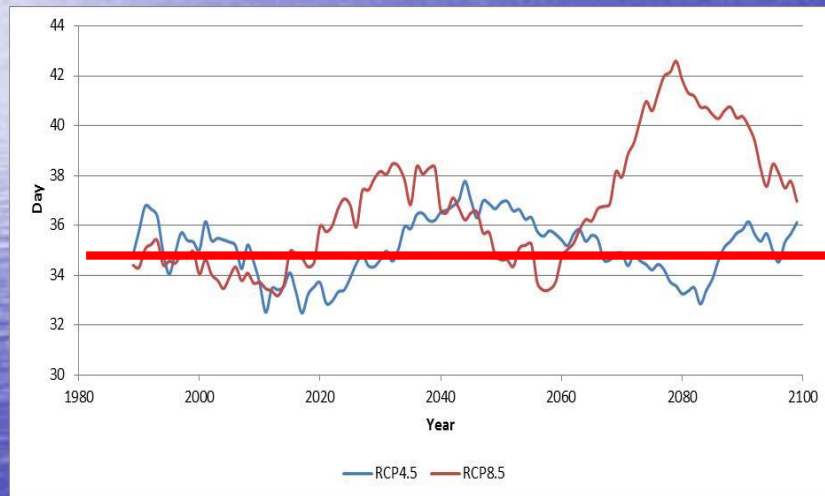
	1986-2005	2046-2065	2081-2100
RCP4.5	7	16	21
RCP8.5	5	15	38



Changes in Precipitation Indices

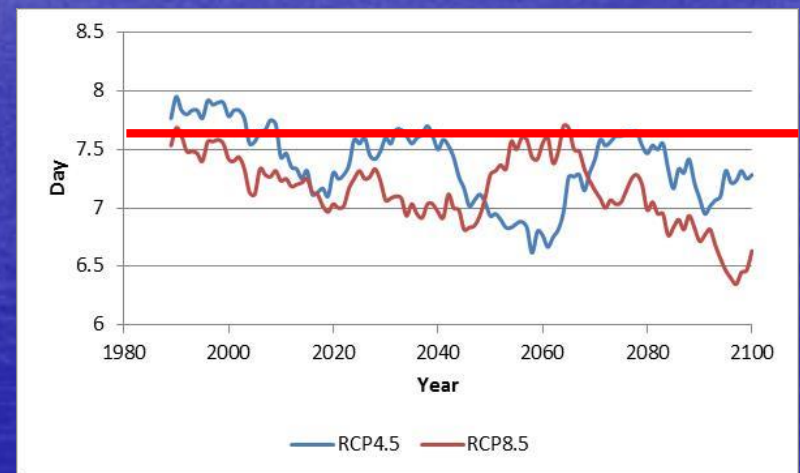
Consecutive dry days

Maximum number of consecutive days with precipitation < 1mm



Consecutive wet days

Maximum number of consecutive days with precipitation ≥ 1mm



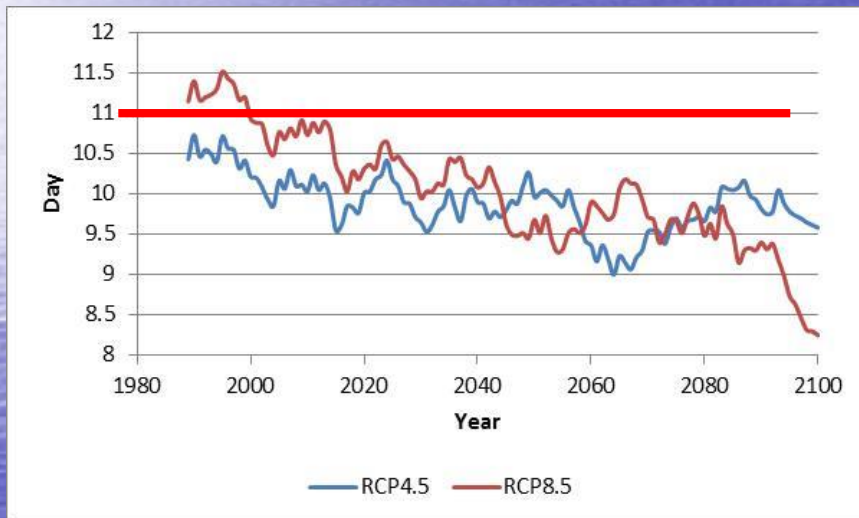
	1986-2005	2046-2065	2081-2100
RCP4.5	36	36	35
RCP8.5	34	35	40

	1986-2005	2046-2065	2081-2100
RCP4.5	7.8	6.9	7.3
RCP8.5	7.5	7.3	6.7

Medjerda River Basin

Heavy precipitation days

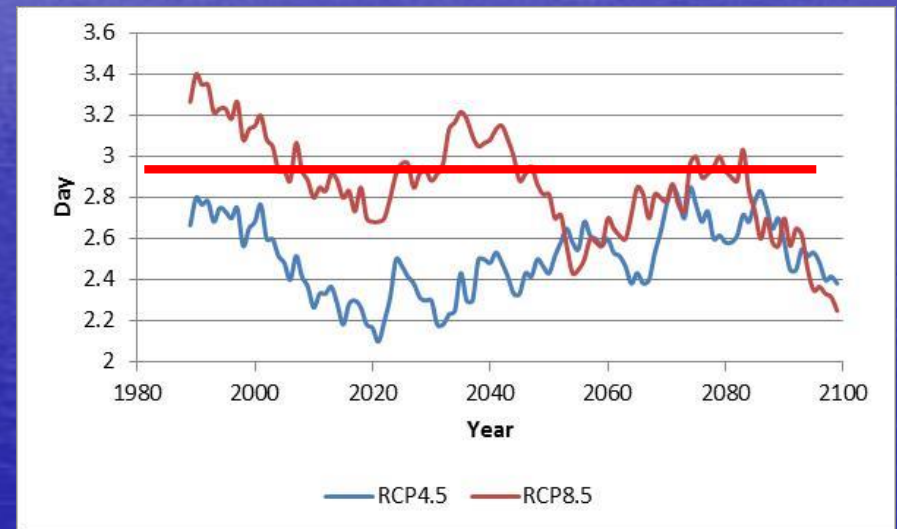
Annual count of days when precipitation $\geq 10\text{mm}$



	1986-2005	2046-2065	2081-2100
RCP4.5	10.4	9.7	9.9
RCP8.5	11.1	9.6	9.1

Heavy precipitation days

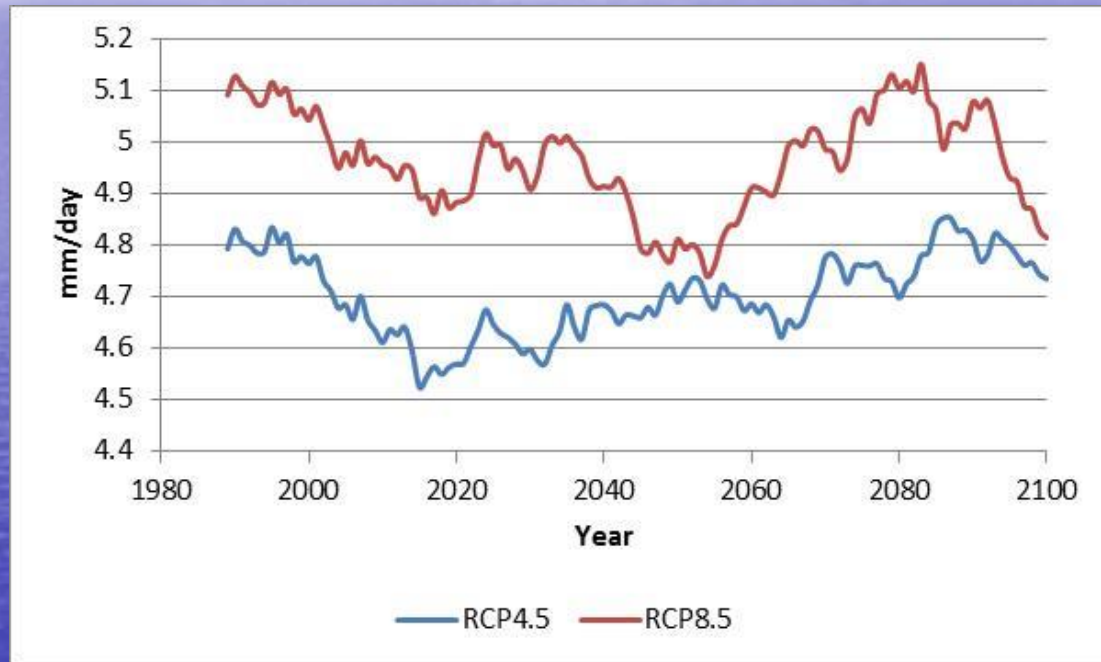
Annual count of days when precipitation $\geq 20\text{mm}$



	1986-2005	2046-2065	2081-2100
RCP4.5	2.7	2.5	2.6
RCP8.5	3.2	2.7	2.6

Simple daily intensity index

Annual total precipitation divided by the number of wet days (defined as PRCP \geq 1.0mm) in the year



	1986-2005	2046-2065	2081-2100
RCP4.5	4.8	4.7	4.8
RCP8.5	5.1	4.8	5.0

Changes in drought Indices



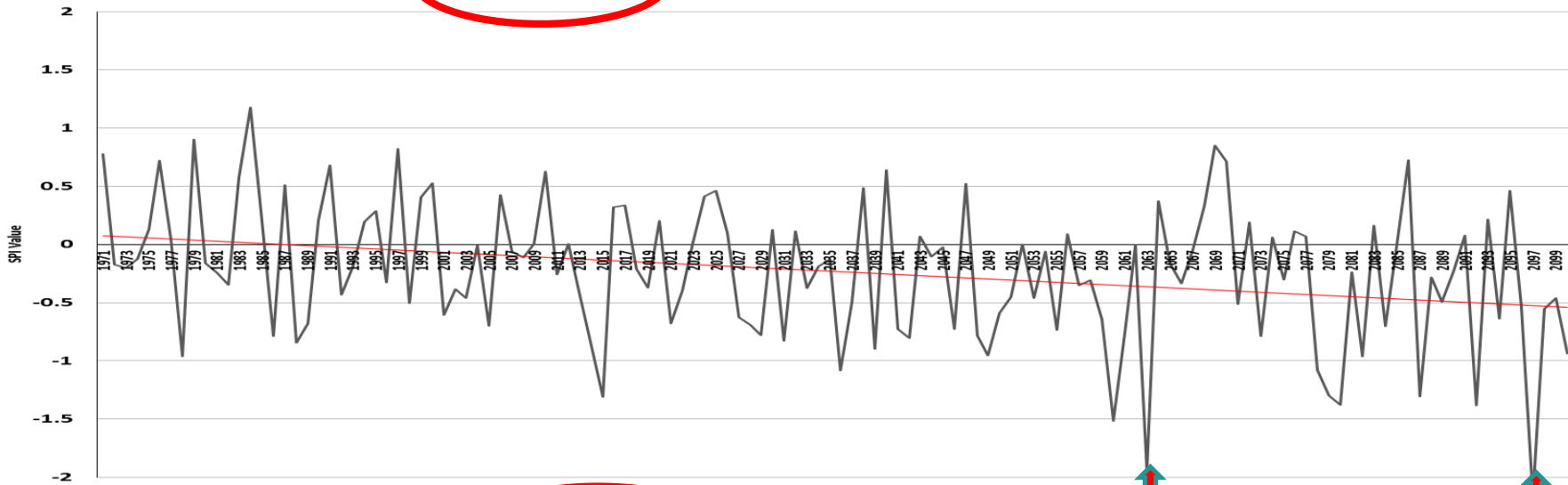
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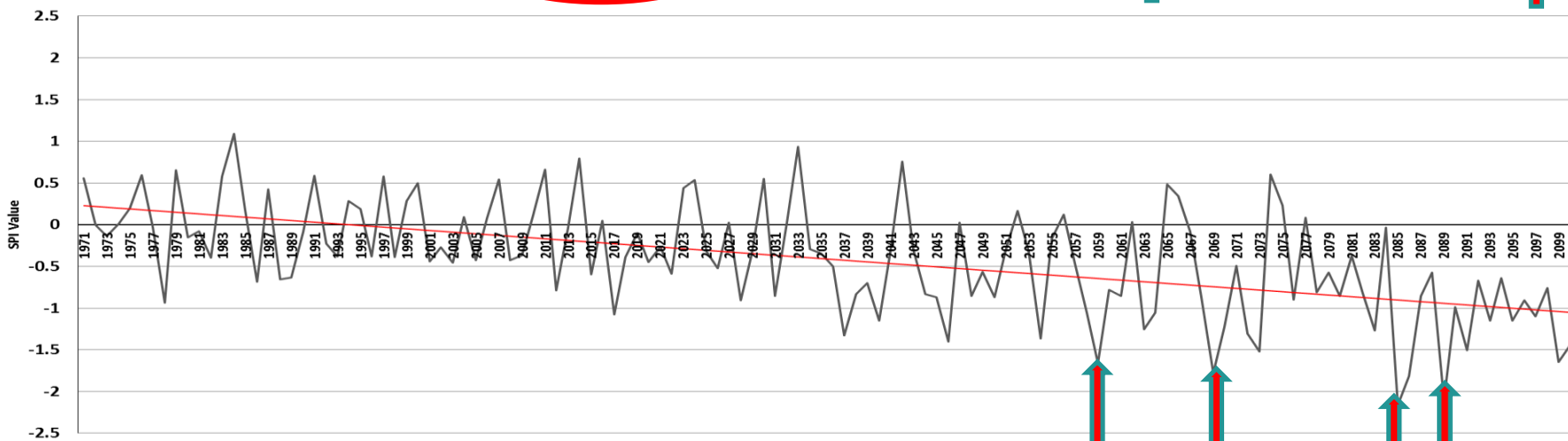
Overall trend of predicted SPI



SPI(6 month) Values_Medjerda_rcp 4.5



SPI(6 month) Values_Medjerda_rcp 8.5





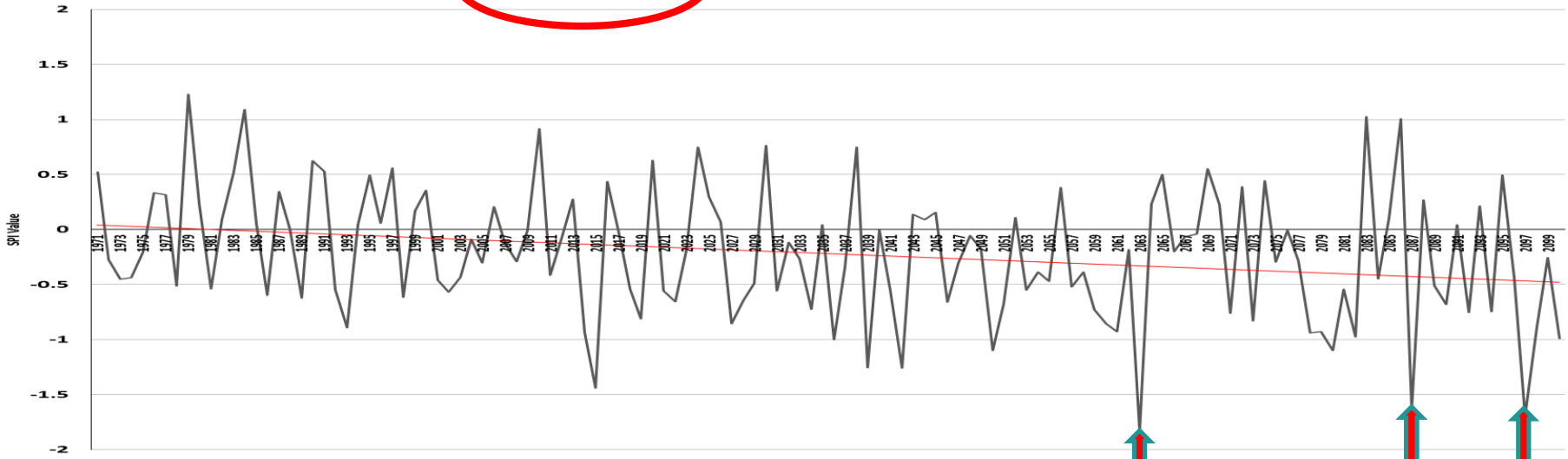
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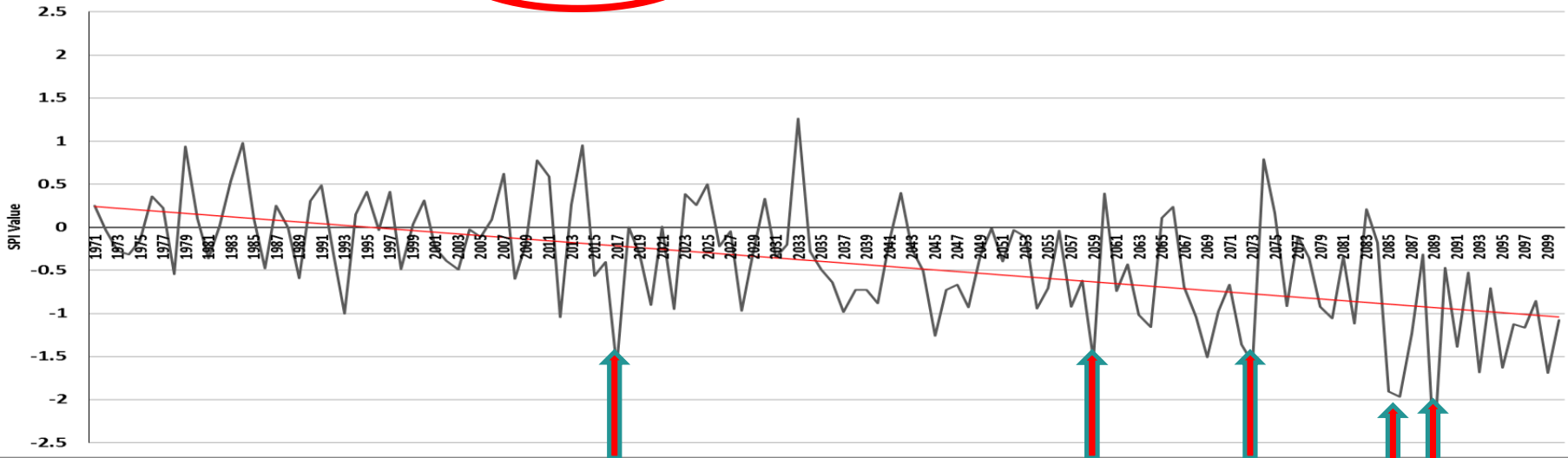
Overall trend of predicted SPI



SPI(12 month) Values_Medjerda_rcp 4.5



SPI(12 month) Values_Medjerda_rcp 8.5



The percentage of time with moderate, severe and extreme drought conditions



SPT values 6 month scale	Drought Conditio n	Reference period	RCP 4.5		RCP 8.5	
			Mid Century	End century	Mid Century	End century
-1 to -1.49	moderate	%60	%70	%70	70%	75%
-1.5 to -2	severe	0	%10	0	5%	15%
<= -2	extreme	0	0	5%	0%	10%
	Total	60%	80%	75%	75%	100%

SPT values 12 month scale	Drought Conditio n	Reference period	RCP 4.5		RCP 8.5	
			Mid Century	End century	Mid Century	End century
-1 to -1.49	moderate	50%	75%	50%	85%	65%
-1.5 to -2	severe	0%	5%	10%	5%	25%
<= -2	extreme	0%	0%	0%	0%	5%
	Total	50%	80%	60%	90%	95%

Wadi Dayqah Basin



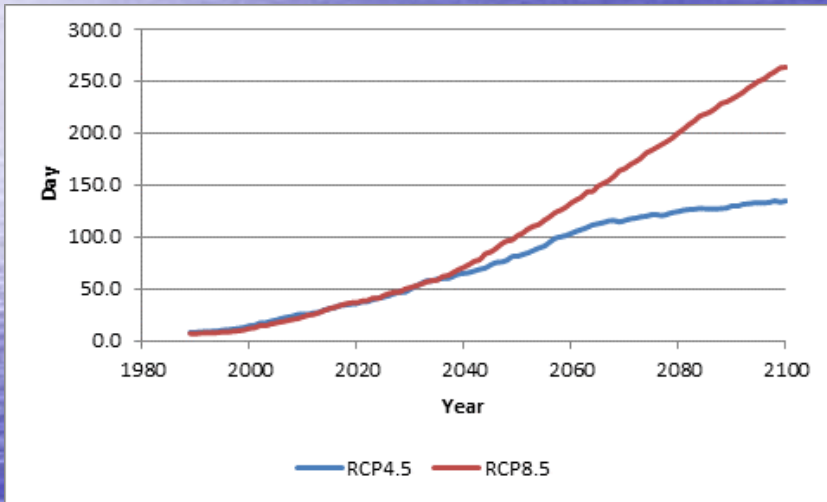


Changes in Temperature Indices

Wadi Dayqah Basin

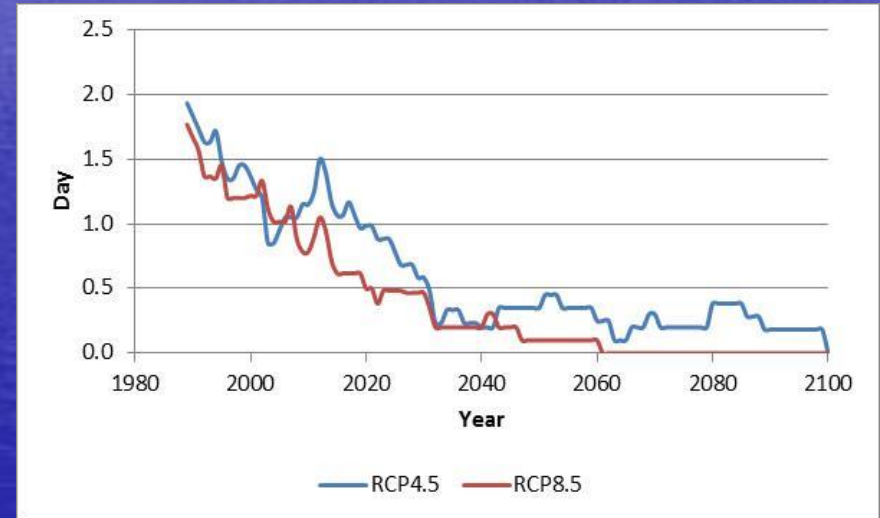
Warm spell duration indicator

Annual count of days with at least 6 consecutive days when maximum temperature > 90th percentile



Cold spell duration indicator

Annual count of days with at least 6 consecutive days when minimum temperature < 10th percentile

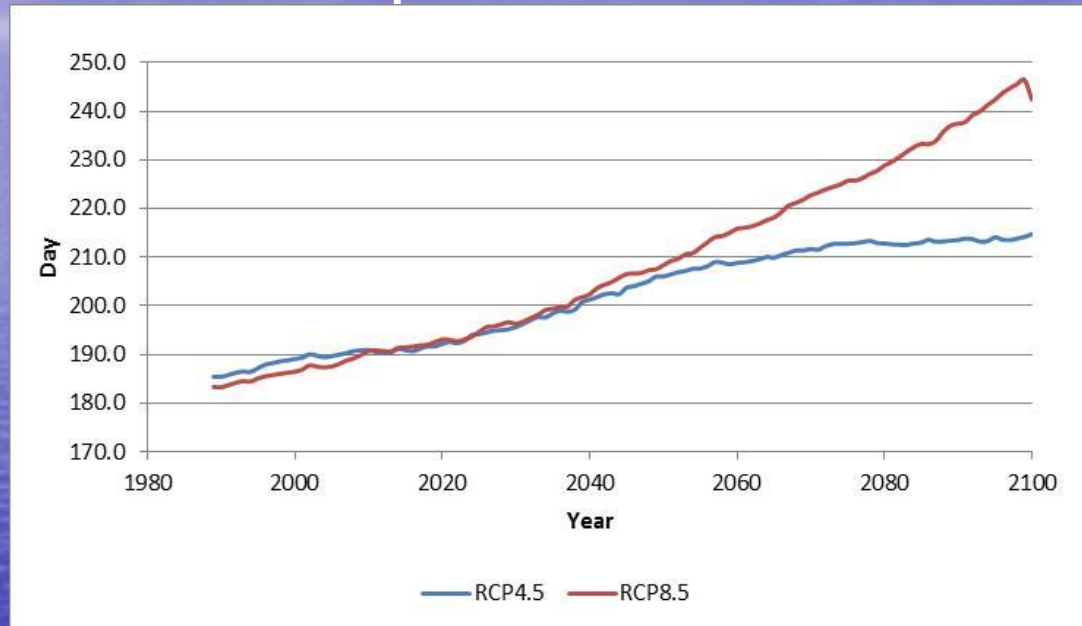


	1986-2005	2046-2065	2081-2100
RCP4.5	13	93	130
RCP8.5	11	117	236

	1986-2005	2046-2065	2081-2100
RCP4.5	1.4	0.3	0.2
RCP8.5	1.3	0.1	0.0

Tropical nights

Annual count when daily minimum temperature > 20°C

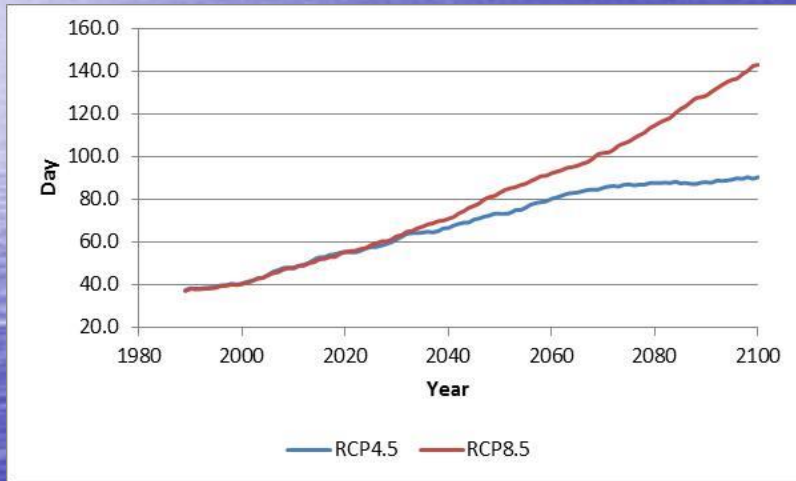


	1986-2005	2046-2065	2081-2100
RCP4.5	188	207	213
RCP8.5	186	212	238

Wadi Dayqah Basin

Number of hot days

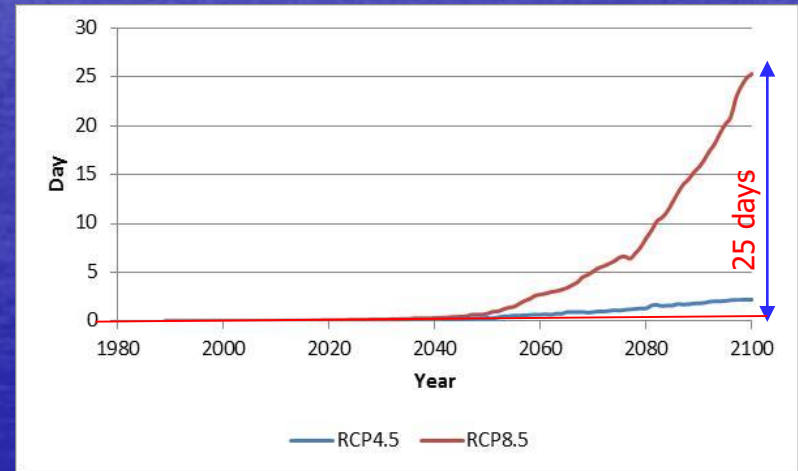
Annual count when daily maximum temperature $>35^{\circ}\text{C}$



	1986-2005	2046-2065	2081-2100
RCP4.5	40.4	76.9	88.7
RCP8.5	40.1	87.6	129.9

Number of very hot days

Annual count when daily maximum temperature $>40^{\circ}\text{C}$



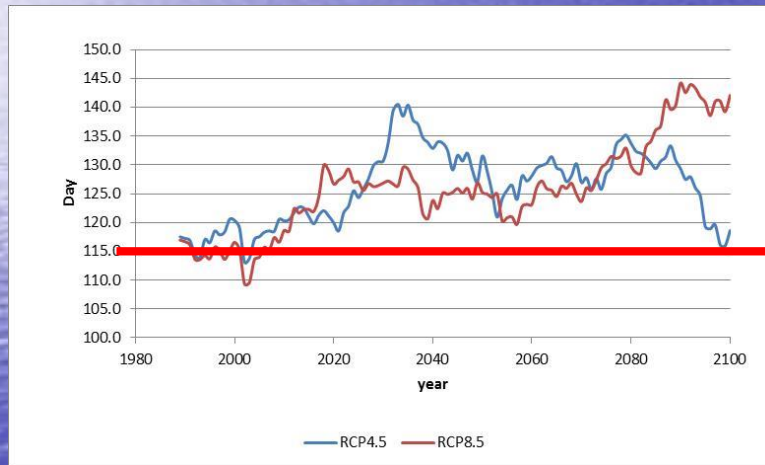
	1986-2005	2046-2065	2081-2100
RCP4.5	0.0	0.5	1.9
RCP8.5	0.0	1.8	16.8



Changes in Precipitation Indices

Consecutive dry days

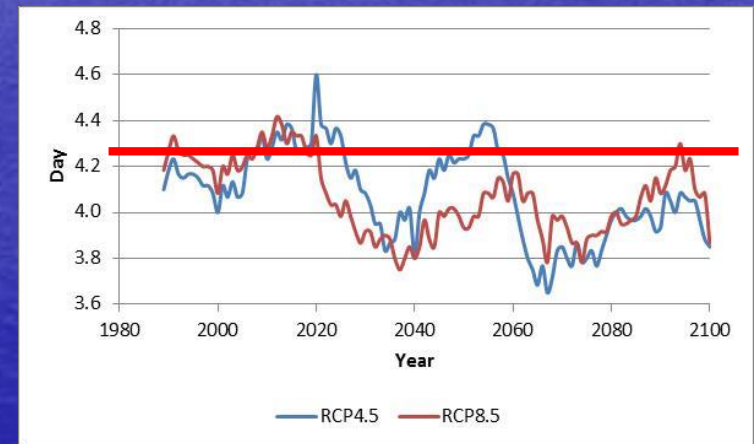
Maximum number of consecutive days with precipitation < 1mm



	1986-2005	2046-2065	2081-2100
RCP4.5	117.0	128	126
RCP8.5	114	124	139

Consecutive wet days

Maximum number of consecutive days with precipitation ≥ 1mm



	1986-2005	2046-2065	2081-2100
RCP4.5	4.1	4.2	4.0
RCP8.5	4.2	4.0	4.1

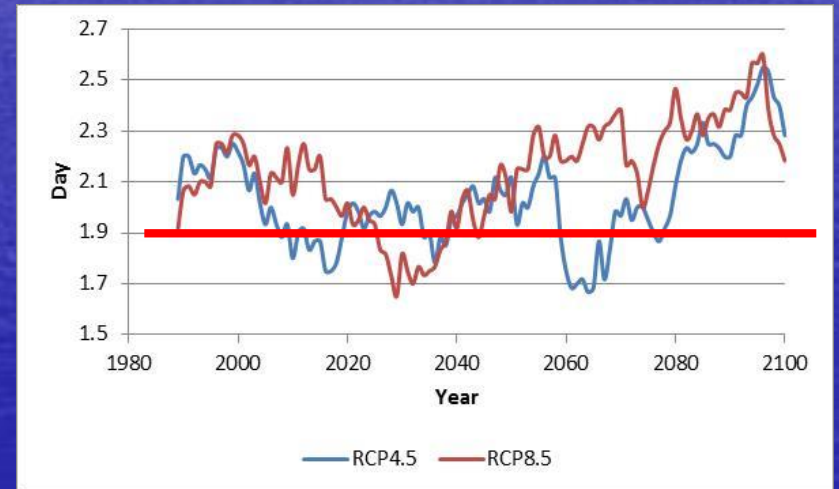
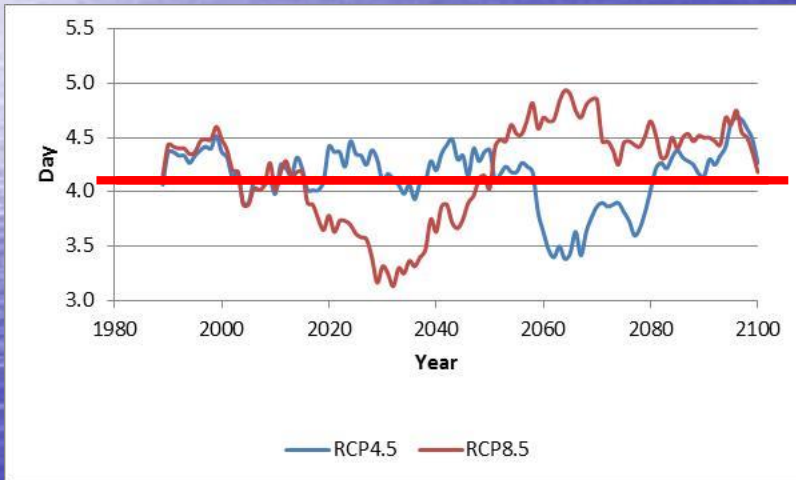
Wadi Dayqah Basin

Heavy precipitation days

Annual count of days when precipitation $\geq 10\text{mm}$

Very Heavy precipitation days

Annual count of days when precipitation $\geq 20\text{mm}$

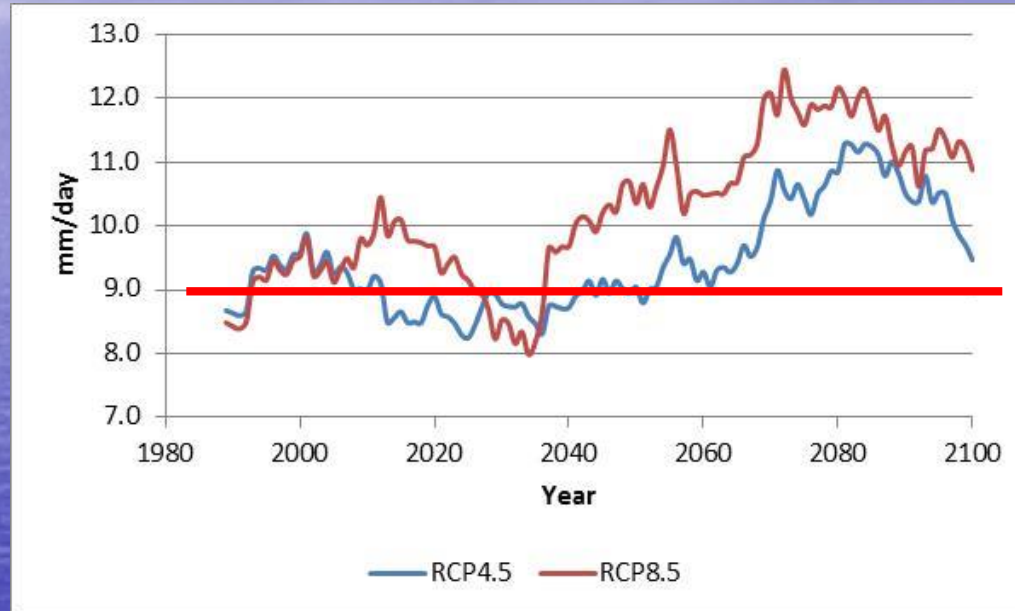


	1986-2005	2046-2065	2081-2100
RCP4.5	4.3	4.0	4.4
RCP8.5	4.3	4.5	4.5

	1986-2005	2046-2065	2081-2100
RCP4.5	2.1	2.0	2.3
RCP8.5	2.1	2.2	2.4

Simple daily intensity index

Annual total precipitation divided by the number of wet days (defined as $PRCP \geq 1.0\text{mm}$) in the year



	1986-2005	2046-2065	2081-2100
RCP4.5	9.2	9.2	10.6
RCP8.5	9.1	10.6	11.4

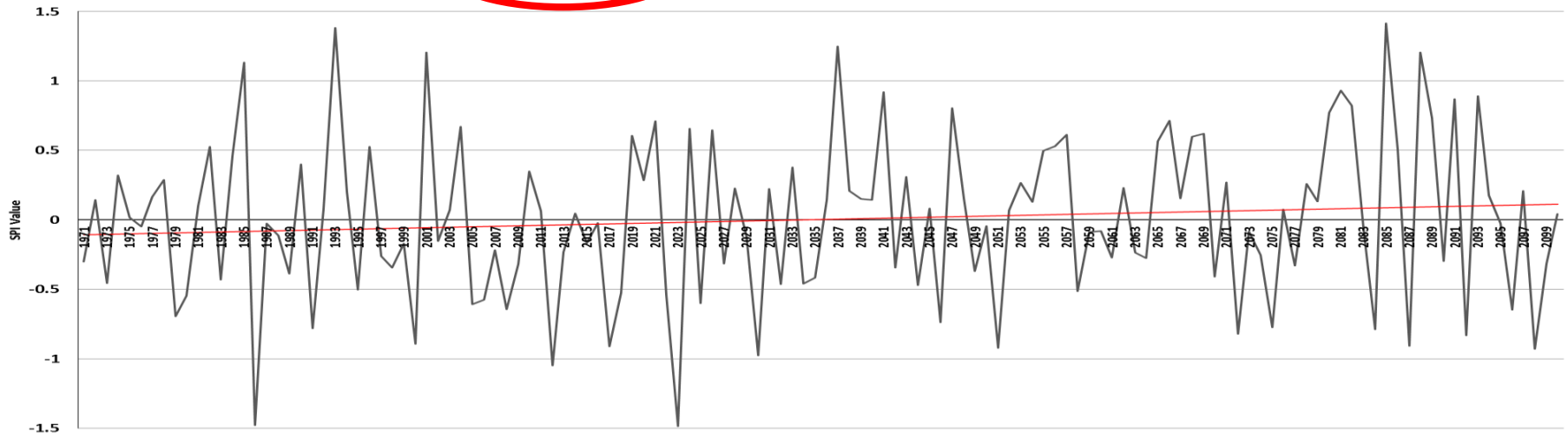


Changes in drought Indices

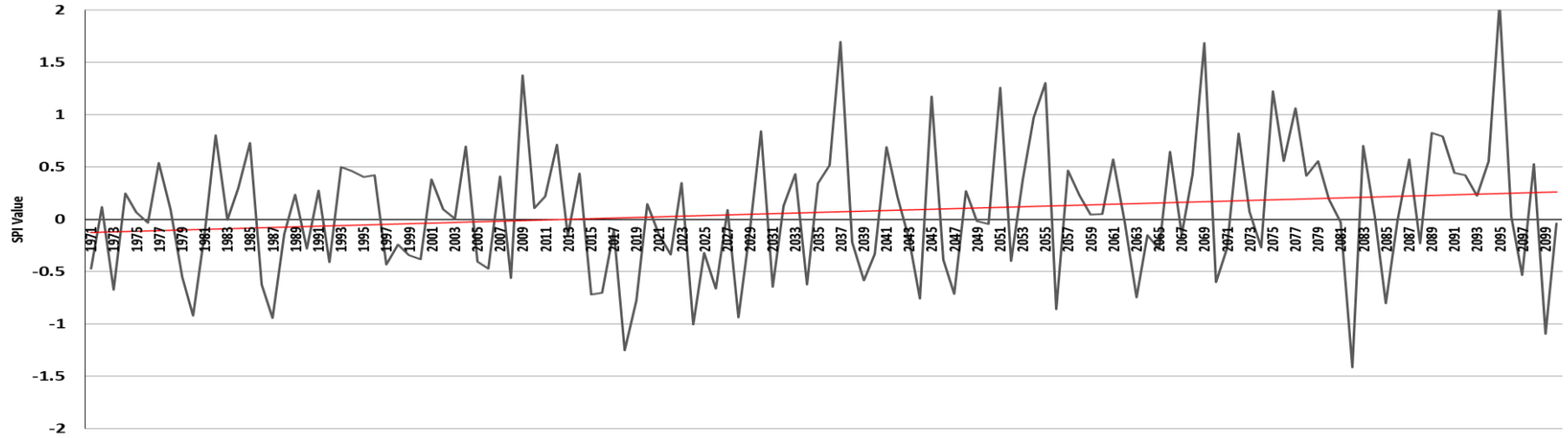
Overall trend of predicted SPI at Wadi Dayqah Basin for period (1985-2100) under a) RCP4.5 and b) RCP8.5 scenarios conditions as derived with 6_month (Apr.) SPI



SPI(6 month) Values_Wadi Dayqah_rcp 4.5



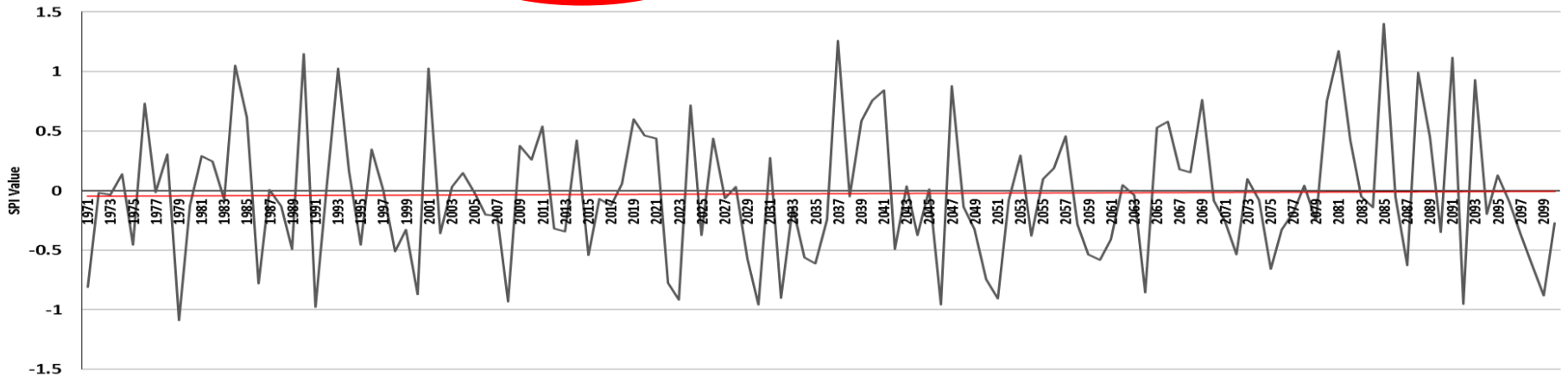
SPI(6 month) Values_Wadi Dayqah_rcp 8.5



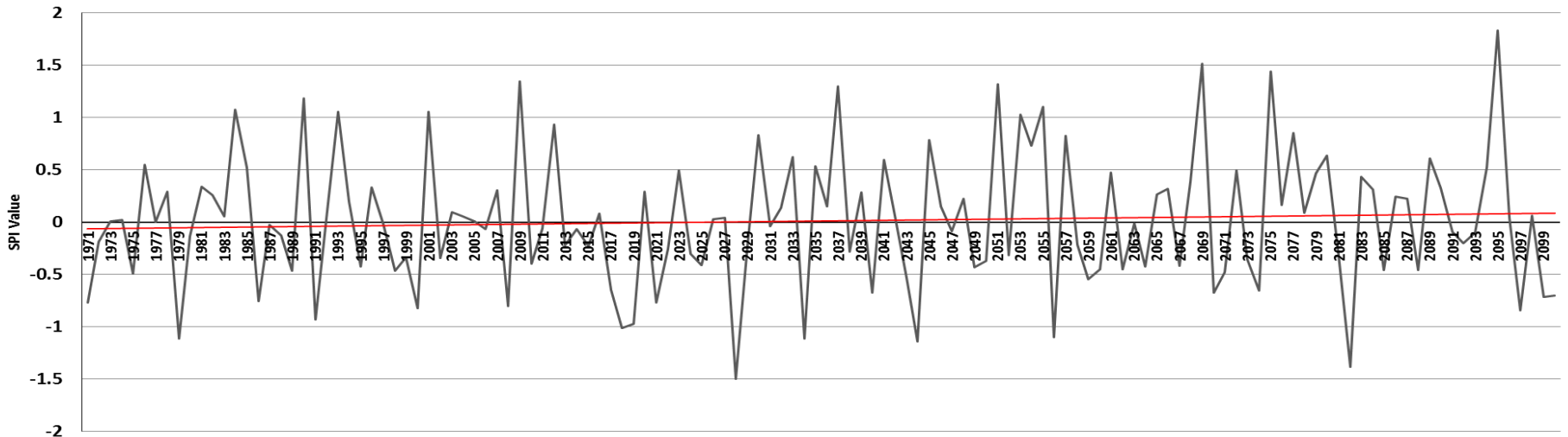
Overall trend of predicted SPI at Wadi Dayqah basin for period (1985-2100) under a) RCP4.5 and b) RCP8.5 scenarios conditions as derived with 12_month (Oct.) SPI



SPI(12 month) Values_Wadi Diqah _rcp 4.5



SPI(12 month) Values_Wadi Diqah _rcp 8.5



The percentage of time with moderate, severe and extreme drought conditions



SPT values 6 month scale	Drought Condition	Reference period	RCP 4.5		RCP 8.5	
			Mid Century	End century	Mid Century	End century
0 to -1.49	moderate	60%	50%	50%	50%	40%
-1.5 to -2	severe	0	0	0	0	0
<= -2	extreme	0	0	0	0	0
	Total	60%	50%	50%	50%	40%

SPT values 12 month scale	Drought Condition	Reference period	RCP 4.5		RCP 8.5	
			Mid Century	End century	Mid Century	End century
0 to -1.49	moderate	%55	%65	%60	%50	%50
-1.5 to -2	severe	%0	%0	%0	%0	0%
<= -2	extreme	%0	%0	%0	%0	%0
	Total	55%	65%	60%	55%	50%

The background is a smooth blue gradient. On the left side, there is a bright, glowing area that resembles a sun or a light source, with a vertical streak of light extending downwards, creating a shimmering effect. The rest of the background is a deep, uniform blue with subtle, wispy white clouds near the top.

summary

summary

At Nahr el Kabir Al-Junoubi basin :

- There is a tendency towards dryer conditions
- There is an increase in heat extremes such as warm spell duration, number of hot days, number of very hot days, and tropical nights over the time period,
- There is an increase of precipitation intensity and heavy precipitation together with increasing consecutive dry days.

summary

At Mejerda Basin:

- There is a tendency towards dryer conditions
- There is an increase in heat extremes such as warm spell duration, number of hot days, number of very hot days, and tropical nights over the time period,
- There is an increase of precipitation intensity and heavy precipitation together with increasing consecutive dry days.

summary

- At Wadi Dayqah Basin :
 - There is a tendency towards wetter conditions,
 - There is an increase in heat extremes such as warm spell duration, number of hot days, number of very hot days, and tropical nights over the time period,
 - There is an increase of precipitation intensity and heavy precipitation together with increasing consecutive dry days, and

The background is a smooth blue gradient. On the left side, there is a bright, glowing area that resembles a sun or moon reflecting on water, creating a shimmering effect. The rest of the background is a solid, deep blue color.

Thanks