A new approach for the definition of extreme anomalous hot and dry weather events in Israel

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ABSTRACT

This study analyzes extreme anomalous hot and dry weather events in Israel based on a new definition for those events. Four thresholds of extreme hot and dry weather conditions are proposed. Thus, an extreme anomalous hot and dry day is defined when two conditions are fulfilled: The standard score of the temperature is above one of the four thresholds and the standard score of the relative humidity is below one of the four thresholds. The main conclusion of this study is that differences in temperature and relative humidity in various geographic regions require a new definition for extreme anomalous hot and dry weather based on a regional basis and not on a unique one for the entire country throughout the year. By establishing various degrees for extreme anomalous hot and dry weather events based on the monthly average and the standard deviation of maximum temperature values and minimum relative humidity values for each region, one can get more accurate definition for those events. This approach may be used worldwide and can serve to analyze possible climatic changes.

Keywords: relative humidity, maximum temperature, extreme weather events, Sharav, Israel.

Un Nuevo enfoque para la definición de eventos extremos anómalos en tiempo caliente y seco en Israel

RESUMEN

Se analizan eventos anómalos extremos de tiempo cálido y seco en Israel basado en una nueva definición para tales eventos. Se proponen cuatro umbrales de condiciones extremas climáticas cálidas y secas. En este sentido, un día anómalo extremo caliente y seco se define cuando se cumplen dos condiciones: La puntuación estándar de la temperatura está por encima de uno de los cuatro umbrales y la puntuación estándar de la humedad relativa es inferior a uno de los cuatro umbrales. La conclusión principal de este estudio es que las diferencias de temperatura y humedad relativa en diversas regiones geográficas requieren una nueva definición para anomalía extrema de clima cálido y seco basado en una base regional y no en uno único para todo el país a través del año. Mediante el establecimiento de varios grados de eventos extremos anómalos de clima cálido y seco y en base a la media mensual y la desviación estándar de los valores de temperatura máxima y mínima y los valores de humedad relativa para cada región, se puede obtener una definición más precisa de tales eventos. Este enfoque puede ser utilizado en todo el mundo y pueden servir para analizar posibles cambios climáticos.

Palabras clave: humedad relativa, temperatura máxima, evento climático extremo, Sharav, Israel.

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INTRODUCTION

Analyses of maximum temperatures (Tmax, hereafter) and/or minimum relative humidity (RH, hereafter) trends in the Mediterranean were reported in several studies (e.g., QUEREDA *et al.* 2000, SERRA *et al*. 2001, FOUNDA *et al*. 2004, ZHANG *et al*. 2005, ZIV & SAARONI, 2011) and in Israel (SAARONI *et al*., 1998, BEN-GAI *et al*. 1999, SAARONI *et al*. 2003).

Extreme hot and dry weather conditions in Israel have been subject to many studies, most of them dealing with the *Sharav* phenomenon. In some studies, the synoptic conditions were analyzed (ALEPRT & ZIV 1989, LEVIN & SAARONI 1999, ALPERT *et al*. 2004a; 2004b, PORAT 2004), while other studies dealt with definitions of the *Sharav* phenomenon. Several definitions, based on temperature and RH thresholds, were proposed, e.g., WINSTANELY, 1972, The Israel Meteorological Service-IMS (two versions), GAT & LOMAS, 1990.

In the first IMS definition (as cited in PORAT 2004), two severity degrees of *Sharav* were defined:

Light *Sharav* when the mean daily RH is < 50% in the coastal plain and < 45% in the inland (note that temperature is not taken into account at all).

Severe *Sharav* when the mean daily RH is < 30% in the coastal plain and < 20% in the inland and Tmax is greater than the mean monthly Tmax (not mentioned how much greater).

In 1994, the IMS updated its definition and included the Tmax in both *Sharav* severities:

Sharav when Tmax is at least **5°C above** the 10 day mean Tmax and > 27°C, and the minimum RH is < 30% in the coastal plain and < 20% in the inland.

Severe *Sharav* when Tmax is at least **10°C above** the 10 day mean Tmax and > 27°C, and the minimum RH is < 30% in the coastal plain and < 20% in the inland.

GAT & LOMAS (1990) presented their definition mainly for agro-meteorological purposes. They added a third category of *Sharav* severity.

Light *Sharav* when 33ºC ≤ Tmax ≤ 35.9ºC and RH < 20%

Moderate *Sharav* when 36ºC ≤ Tmax ≤ 38.9ºC and RH < 20%

Severe *Sharav* when 39ºC ≤ Tmax and RH < 20%

There are some drawbacks in these definitions, which some of the researchers were aware of:

1. Differences of the mean Tmax and RH among the various regions are not taken into account apart from a rough differentiation between the coastal plain and the inland in the IMS definition.

2. Differences of the mean Tmax and RH between the seasons are completely ignored.

3. Differences between the severities of the *Sharav* conditions depend solely on the temperature as the threshold of the RH remains constant in all *Sharav* levels in both definitions of the IMS (from1994) and of GAT & LOMAS (1990).

As Tmax and RH vary a great deal among the various regions of Israel and throughout the year (Table 1), in some hot and dry regions, the conditions during several months fit into the above definitions, whereas in other, these definitions are obtained rarely although in some cases, very unusual conditions for the region and the season exist, but yet not enough to be regarded as a *Sharav* event.

This study presents a new approach for defining and identifying extreme anomalous hot and dry weather events in Israel based on the characteristics of each region in each season. However, the present study does not aim at presenting a new definition to the *Sharav* phenomenon. Furthermore, time series of anomalous conditions are analyzed in order to identify changes in the frequency of hot and dry conditions. This is followed by two case studies for our new definition of extreme anomalous hot and dry weather conditions comparing it to previous definitions.

DATABASE AND METHODOLOGY

Daily Tmax and minimum RH for the years 1964-2008 in 12 meteorological stations in various regions of Israel from the IMS network were selected (Table 1, Fig 1). These stations were selected as having the longest available data throughout the years with the least cases of missing values. The IMS, as a routine, checks the data for outliers, homogeneity and errors. RH values were calculated based on dry and wet bulb thermometers.

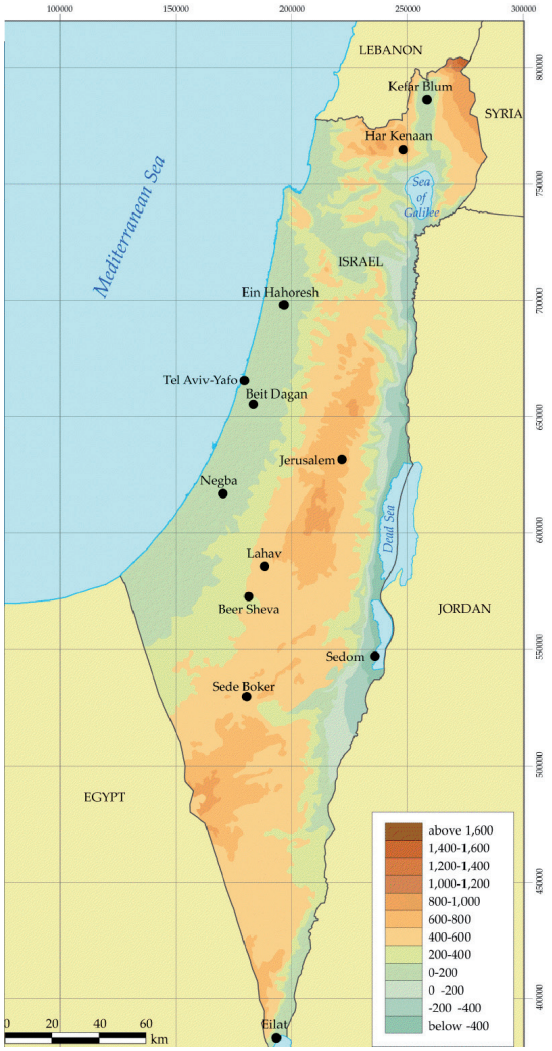

Fig.1. Location map of the meteorological stations used in this study.

Fig. 1. Mapa de localización de las estaciones meteorológicas usadas en este estudio.

Table 1. Mean monthly Tmax and mean monthly minimum RH in February, April, July and October (see Figure 1)

Tabla 1. Medias mensuales de Tmax y medias mínimo mensual RH en febrero, abril, julio y octubre (ver figura 1)

Station (number of analyzed years)	February		April		July		October	
	mean Tmax (°C)	mean RH (%)	mean Tmax (°C)	mean RH (%)	mean Tmax (°C)	mean RH (%)	mean Tmax (°C)	mean RH (%)
Kefar Blum (45)	18.0	53	25.7	42	34.2	42	30.4	42
Har Kenaan (44)	10.7	63	19.3	42	29.8	36	23.8	42
Ein Hahoresh (38)	18.3	55	24.3	50	30.5	58	28.4	52
Tel Aviv (37)	18.0	52	23.0	51	29.4	63	27.2	53
Beit Dagan (43)	18.7	50	24.6	44	30.9	53	28.2	48
Jerusalem (45)	13.1	52	21.2	36	28.9	35	24.8	39
Negba (45)	18.0	56	24.6	46	30.9	52	27.9	50
Lahav (42)	16.1	56	24.3	41	32.0	43	27.5	46
Beer Sheva (45)	18.1	44	26.2	31	33.6	33	29.0	37
Sedom (41)	22.0	37	29.8	27	39.6	23	32.4	33
Sede Boker (45)	16.6	47	25.1	32	32.7	33	27.4	40
Eilat (45)	22.7	25	30.9	16	39.9	14	33.0	24

For each station, the monthly means and the standard deviations for both parameters (Tmax and minimum RH) were calculated. Anomalous hot and dry conditions were defined as a combination of above normal Tmax values and below normal RH values. Daily Tmax and RH. values were standardized as follows:

$$T_z = \frac{T_{max_i} - \overline{T_{max}}}{\sigma T_{max}} \qquad RH_z = \frac{RH_{min_i} - \overline{RH_{mın}}}{\sigma RH_{min}}$$

where:

T_z and RH_z are the standard scores of the temperature and relative humidity, respectively.

T_{max_i} and RH_{min_i} are the daily values of the temperature and relative humidity, respectively.

$\overline{T_{max}}$ and $\overline{RH_{mın}}$ are the monthly average temperature and relative humidity, respectively.

σT_{max} and σRH_{min} are the corresponding standard deviations of the temperature and relative humidity, respectively.

Four categories of the severity of the hot and dry conditions were defined based on the calculated standard scores (Table 2).

All calculations were made using Microsoft® Excel 2003 and later Microsoft® Excel 2010 with VBscript macros' feature and Microsoft® Visual Basic 2008 Express. The final data analysis was uploaded to Microsoft® Access database for future use.

Table 2. Definitions of anomalous hot and dry conditions based on z scores of Tmax and RHmin

Tabla 2. Definición de condiciones anómalas calientes y secas basadas en puntuación z de Tmax y RHmin

		Tmax z scores			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z scores	z <|-0.5|	no extreme conditions	no extreme conditions	very mild conditions	mild conditions
	|-0.5| ≤ z <|-1|	no extreme conditions	very mild conditions	mild conditions	moderate conditions
	|-1| ≤ z <|-1.5|	very mild conditions	mild conditions	moderate conditions	extreme conditions
	|-1.5| ≤ z	mild conditions	moderate conditions	extreme conditions	very extreme conditions

RESULTS AND DISCUSSION

Table 2 presents a combination of 16 different temperature and humidity conditions according to the calculated thresholds as described above. In 3 out of the 16 combinations, with the smallest deviations from the normal values, no anomalous hot and dry conditions occurred. In the rest 13 combinations, there were anomalous conditions of various severities: *very mild, mild, moderate, extreme and very extreme.*

Table 3 presents the mean annual number of days with anomalous hot and dry weather conditions according to the 16 combinations presented in Table 2, in all stations. The total number of days in each station, in all 16 categories, sums to 365 (or very close to that figure, due to rounding). Although anomalous hot and dry conditions may occur all year round, their total number sums to not more than 2.5 to 3 months leaving most of the year (between 9 to 9.5 months), without anomalous hot and dry conditions.

Figure 2 presents the seasonal distribution of days with anomalous hot and dry weather conditions in the different stations listed in Table 3.

Previous studies have shown that the spring is the season with the largest number of days with extreme anomalous hot and dry weather conditions followed by the autumn (PORAT 2004). In this study spring is also the season with the largest number of days with extreme anomalous hot and dry weather conditions in 6 of the 12 meteorological stations. However, winter appears to be in the second place in 5 out of the 12 meteorological stations. In the southern region of Israel (Sedom and Eilat) summer has the largest number of days with anomalous hot and dry conditions.

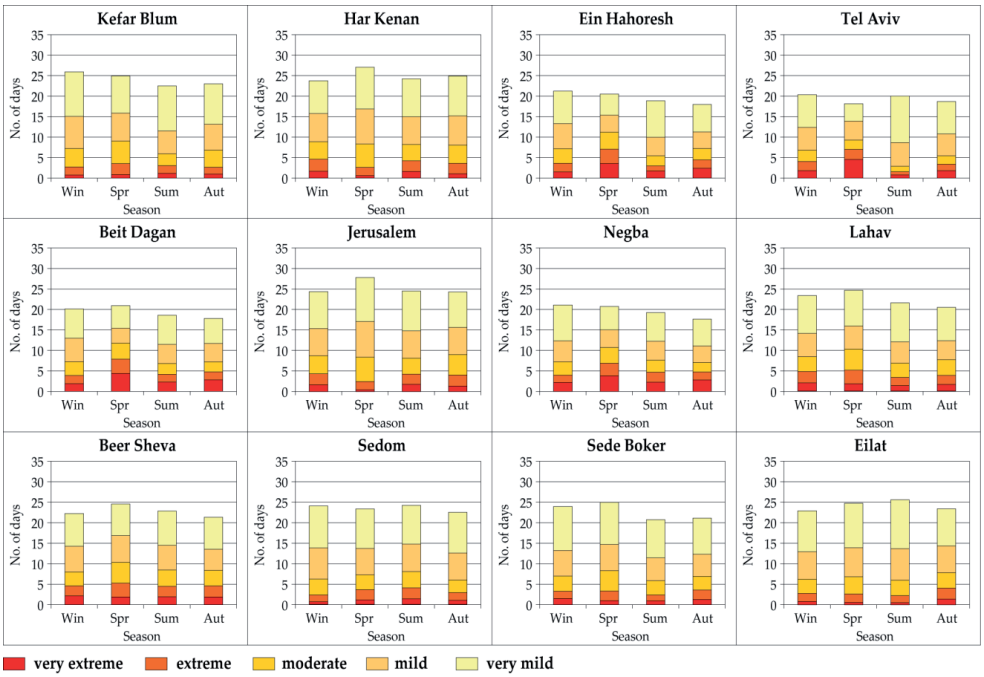

Fig. 2. Seasonal average number of days with extreme anomalous hot and dry weather conditions.

Fig. 2. Promedio estacional de número de días con anomalías extremas de condición de tiempo caliente y seco.

Analysis of the mean seasonal number of anomalous weather conditions, reveals that *extreme* and *very extreme* conditions occur mainly in spring, whereas, *mild* and *very mild* conditions occur mainly in Winter. Furthermore, these tendencies tend to be more evident in the coastal stations. It should be made clear, that in summer, despite the very high temperatures, there are only few anomalous cases due to the relatively small variability of Tmax and RH (Table 4).

Analysis of trends of annual number of days with anomalous hot and dry weather conditions (Fig. 3) reveals a significant increase in 6 stations, while in the remaining 6 stations no significant trend was detected. This means that there is a certain tendency of an increase in the frequency of hot and dry conditions only in some parts of the country. The increase rate in the significant cases varies between 0.41 [d/yr] in Jerusalem to 0.99 [d/yr] in Sedom. Throughout the period of the research, 2008 had the largest number of extreme anomalous hot and dry weather conditions in 6 out of the 12 meteorological stations.

Table 3. Mean annual number of days with extreme anomalous hot and dry conditions. Background colors similar as in Table 2

Tabla 3. Media anual de días con anomalías extremas de condiciones calientes y secas. Colores de fondo similares a los de la tabla 2

Kefar Blum		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	203	30	8	2
	|-0.5| ≤ z <|-1|	35	20	7	1
	|-1| ≤ z <|-1.5|	13	15	11	3
	|-1.5| ≤ z	3	5	5	4

Har Kenaan		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	210	25	3	<1
	|-0.5| ≤ z <|-1|	30	23	8	1
	|-1| ≤ z <|-1.5|	11	17	12	3
	|-1.5| ≤ z	4	5	7	5

Ein Hahoresh		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	225	34	7	2
	|-0.5| ≤ z <|-1|	27	9	3	1
	|-1| ≤ z <|-1.5|	12	7	5	2
	|-1.5| ≤ z	7	7	7	9

Tel Aviv		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	222	36	10	3
	|-0.5| ≤ z <|-1|	31	7	2	1
	|-1| ≤ z <|-1.5|	14	5	3	2
	|-1.5| ≤ z	11	5	5	9

Beit Dagan		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	230	32	6	1
	|-0.5| ≤ z <|-1|	25	9	3	1
	|-1| ≤ z <|-1.5|	12	8	5	2
	|-1.5| ≤ z	6	6	7	11

Jerusalem		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	211	23	3	<1
	|-0.5| ≤ z <|-1|	30	23	8	1
	|-1| ≤ z <|-1.5|	11	16	12	4
	|-1.5| ≤ z	3	6	6	5

Negba		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	230	30	6	1
	|-0.5| ≤ z <|-1|	26	11	4	1
	|-1| ≤ z <|-1.5|	11	8	5	2
	|-1.5| ≤ z	5	6	7	11

Lahav		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	215	28	6	1
	|-0.5| ≤ z <|-1|	32	18	6	1
	|-1| ≤ z <|-1.5|	12	12	10	3
	|-1.5| ≤ z	2	5	7	7

Beer Sheva		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	218	27	6	1
	|-0.5| ≤ z <|-1|	29	15	5	1
	|-1| ≤ z <|-1.5|	11	13	9	3
	|-1.5| ≤ z	4	6	8	8

Sede Boker		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	209	27	7	1
	|-0.5| ≤ z <|-1|	38	19	7	2
	|-1| ≤ z <|-1.5|	13	13	11	4
	|-1.5| ≤ z	2	3	4	5

Sedom		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	203	37	9	2
	|-0.5| ≤ z <|-1|	32	15	7	2
	|-1| ≤ z <|-1.5|	15	11	7	2
	|-1.5| ≤ z	8	6	6	4

Eilat		Tmax z score			
		z <0.5	0.5≤ z <1.25	1.25≤ z <2	2≤ z
RH z score	z <|-0.5|	199	32	8	1
	|-0.5| ≤ z <|-1|	37	18	10	2
	|-1| ≤ z <|-1.5|	15	11	8	4
	|-1.5| ≤ z	6	5	5	3

Table 4. Mean seasonal number of days with extreme anomalous hot and dry conditions

Tabla 4. Medias estacionales de número de días con anomalías extremas de condiciones calientes y secas

		Severity					Severity		
		Extreme and very extreme	Moderate	Mild and very mild			Extreme and very extreme	Moderate	Mild and very mild
Kefar Blum	Win	3	5	19	Har Kenaan	Win	5	4	15
	Spr	4	5	16		Spr	3	6	19
	Sum	3	3	17		Sum	4	4	16
	Aut	3	4	16		Aut	4	4	17
Ein Haho-resh	Win	4	4	14	Tel Aviv	Win	4	3	14
	Spr	7	4	9		Spr	7	2	9
	Sum	3	2	13		Sum	2	1	17
	Aut	4	3	11		Aut	3	2	13
Beit Dagan	Win	4	3	13	Jerusalem	Win	4	4	16
	Spr	8	4	9		Spr	2	6	19
	Sum	4	3	12		Sum	4	4	16
	Aut	5	2	11		Aut	4	5	15
Negba	Win	4	3	14	Lahav	Win	5	4	15
	Spr	7	4	10		Spr	5	5	14
	Sum	5	3	12		Sum	3	3	15
	Aut	5	2	11		Aut	4	4	13
Beer Sheva	Win	5	3	14	Sedom	Win	2	4	18
	Spr	5	5	14		Spr	4	4	16
	Sum	4	4	14		Sum	4	4	16
	Aut	5	4	13		Aut	3	3	17
Sede Boker	Win	3	4	17	Eilat	Win	3	3	17
	Spr	3	5	17		Spr	3	4	18
	Sum	2	3	15		Sum	2	4	20
	Aut	4	3	14		Aut	4	4	16

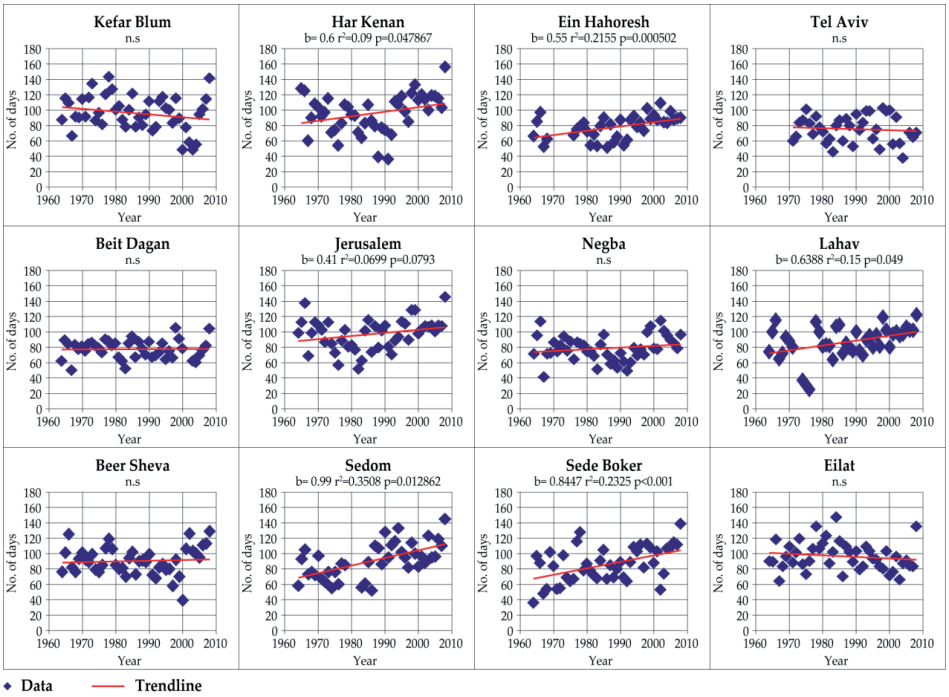

Fig. 3. Annual number of days with extreme anomalous hot and dry weather conditions.

Fig. 3. Número de días anuales con anomalías extremas de condiciones de tiempo caliente y seco.

Analysis of case studies according to the new definition

Case study 1 – 23-25.2.2006

On 23-25/2/2006 an episode of extreme hot and dry weather conditions occurred. Table 1 presents the mean Tmax and minimum RH in February and Table 5 presents the analysis of this event.

Table 5. The 23-25.2.2006 event (background colors similar as in Table 2)

Tabla 5. Evento del 23-25 de febrero de 2006 (colores de fondo similares a los de Tabla 2)

	23.2.2006				24.2.2006				25.2.2006			
Station	Tmax [°C]	RH [%]	Tmax z score	RH z score	Tmax [°C]	RH [%]	Tmax z score	RH z score	Tmax [°C]	RH [%]	Tmax z score	RH z score
Kefar Blum	23.8	28	1.46	-1.25	25.4	19	1.86	-1.69	21.8	31	0.96	-1.10
Har Kenaan	15.6	32	1.27	-1.43	16.5	25	1.51	-1.76	17.2	28	1.69	-1.62
Ein Hahoresh	24.3	22	1.83	-1.99	27.3	19	2.73	-2.17	22.2	57	1.20	0.11
Tel Aviv	20.1	33	0.68	-1.20	21.9	23	1.27	-1.86	19.0	57	0.31	0.39
Beit Dagan	24.4	27	1.70	-1.64	27.2	19	2.51	-2.20	22.6	55	1.17	0.31
Jerusalem	18.0	35	1.14	-0.79	21.0	24	1.84	-1.30	21.9	26	2.05	-1.21
Negba	23.6	58	1.58	0.13	25.4	23	2.10	-2.16	21.4	30	0.96	-1.70
Lahav	21.0	26	1.24	-1.39	23.6	18	1.88	-1.77	24.8	30	2.18	-1.20
Beer Sheva	24.9	25	1.67	-1.11	27.7	13	2.36	-1.81	27.6	23	2.33	-1.22
Sedom	27.4	17	2.09	-2.09	27.6	23	2.17	-1.45	25.2	27	1.24	-1.03
Sede Boker	21.0	25	1.17	-1.19	24.8	14	2.18	-1.78	24.0	21	1.97	-1.41
Eilat	28.1	15	1.68	-1.14	27.6	20	1.53	-0.56	29.9	16	2.24	-1.02

On 23/2/2006 in most regions of Israel according to the new definition, the levels of *mild to moderate* anomalous hot and dry weather conditions occurred with the exception of the coastal region where *extreme* anomalous conditions occurred, and in Sedom on the south/east part of the country where *very extreme* conditions occurred mainly due to a severe decline in RH.

On 24.2.2006 *extreme to very extreme* anomalous hot and dry weather conditions were in most regions, with Tmax over 25°C and minimum RH under 20%.

On 25.2.2006 *extreme* anomalous weather conditions still remained in the mountain range and in the southern region of Israel while in the coastal plain, weather conditions were normal for the season.

This event demonstrates that extreme anomalous hot and dry conditions may occur throughout the year and in various severity degrees across the country. According to the later definition of the IMS, this event would be regarded as a *Sharav* only in Eilat on the 23.2.2006, in five stations on the 24.2.2006 (Ein Hahoresh, Beit Dagan, Beer Sheva, Sedom and Eilat) and only in Sedom and Eilat on the 25.2.2006. According to GAT & LOMAS (1990), the entire event would not be regarded as a *Sharav* at all. According to our approach during these three days unusual hot and dry conditions to the season occurred in all stations on the 24.2.2006 and in most stations in the remaining two other days.

Case study 2 – 9-11.7.2006

On 9-11.7.2006 extreme July hot weather conditions occurred. Table 1 presents the mean Tmax and minimum RH in July and Table 6 presents the analysis of this event.

Table 6. The 9-11.7.2006 event. Figures in bold present Extreme Sharav conditions according to GAT & LOMAS (1990). (Background colors similar as in Table 2)

Table 6. Evento del 9-11 de julio de 2006. Las figuras en negrita representan las condiciones de Extremo Sharav de acuerdo a GAT & LOMAS (1990). (Colores de fondo similares a los de la Tabla 2)

Station	9.7.2006				10.7.2006				11.7.2006			
	Tmax [°C]	RH [%]	Tmax z score	RH z score	Tmax [°C]	RH [%]	Tmax z score	RH z score	Tmax [°C]	RH [%]	Tmax z score	RH z score
Kefar Blum	34.0	38	-0.08	-0.38	33.6	30	-0.25	-1.13	33.5	35	-0.30	-0.66
Har Kenaan	28.5	37	-0.51	0.11	28.2	37	-0.62	0.11	28.2	36	-0.62	0.02
Ein Hahoresh	30.7	54	0.15	-0.65	30.6	50	0.07	-1.26	30.9	56	0.30	-0.34
Tel Aviv	29.2	63	-0.11	0.12	29.4	59	0.09	-0.40	29.1	61	-0.20	-0.14
Beit Dagan	30.9	50	0.06	-0.46	30.3	48	-0.38	-0.77	30.9	53	0.06	0.01
Jerusalem	28.4	32	-0.20	-0.24	28.2	38	-0.27	0.23	28.2	30	-0.27	-0.40
Negba	30.9	43	0.00	-1.08	30.2	48	-0.43	-0.47	31.2	43	0.18	-1.08
Lahav	31.8	31	-0.08	-0.78	31.6	30	-0.17	-0.85	32.6	23	0.27	-1.32
Beer Sheva	33.6	31	0.00	-0.23	32.9	28	-0.31	-0.57	34.2	21	0.25	-1.37
Sedom	**39.6**	**19**	-0.02	-0.71	**40.0**	**18**	0.18	-0.87	38.4	22	-0.62	-0.22
Sede Boker	31.5	28	-0.56	-0.33	31.1	24	-0.74	-0.62	32.5	23	-0.11	-0.69
Eilat	**39.0**	**14**	-0.42	0.07	**39.4**	**12**	-0.23	-0.34	**39.4**	**13**	-0.23	-0.13

On 9.7.2006 in most regions of Israel (based on our approach), typical July weather conditions were throughout the country, except for Negba, where according to our definition *very mild* anomalous conditions occurred. According to GAT & LOMAS' definition a *Severe Sharav* occurred in Sedom and Eilat even though temperatures were below normal in these two stations.

On 10.7.2006 in most regions of Israel according to the new definition, typical July weather conditions were throughout the country, except for Kefar Blum and Ein Hahoresh, where according to our analysis *very mild* anomalous conditions occurred. According to GAT & LOMAS definition to *Sharav*, a *Severe Sharav* conditions occurred in Sedom and Eilat.

On 11.7.2006 in most regions of Israel according to the new definition, typical July weather conditions were throughout the country, except for Negba, Lahav and Beer Sheva, where according to our definition *very mild* anomalous conditions occurred. According to GAT & LOMAS' definition to *Sharav*, a *Severe Sharav* conditions occurred in Eilat. In Beer Sheva a *Light Sharav* occurred regarding the temperature limit, while RH was just 1% above the limit. In Sedom a *Moderate Sharav* occurred regarding the temperature limit, while RH was just 2% above the limit.

This event demonstrates that according to our definition a typical hot day in July in the southern region of Israel will not be regarded as an anomalous one, while according to other definitions such as GAT & LOMAS which make no differentiation between the various regions, such hot and dry day will be regarded as a *Sharav* day.

These two case studies demonstrate the advantages of our approach as compared to previous definitions. For people living in a certain region and used to the climatic conditions there, the first case study demonstrated exceptional hot and dry conditions they felt (regardless of where they live) even though Tmax and RH didn't fit into a certain threshold and therefore weren't considered as a *Sharav* day. In the second case study, on the contrary, people in many regions felt more bearable temperatures than normal, but as these normal conditions (or even below normal) are above the defined thresholds in some stations, they were considered as *Severe Sharav* conditions.

SUMMARY AND CONCLUSIONS

Extreme anomalous hot and dry weather conditions were subject to studies dealing with the *Sharav* phenomenon. Most definitions to this phenomenon were based on unique thresholds for temperature and RH for entire Israel as one single region in some studies, or by dividing Israel into two regions: a coastal regions and an inland region. Although the authors were aware of the problems caused by their definitions they didn't suggest or applied other approaches.

This study presents a new approach based on monthly average of Tmax and minimum RH. The differences in the average of Tmax and minimum RH values between the various regions in Israel make a better basis for establishing a new definition for various levels of anomalous hot and dry conditions.

As the severity of the anomalous cases is defined in terms of z scores, it makes the present approach applicable anywhere in the world regardless of the climate. It also enables to analyze time series of extreme conditions.

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