Future vulnerability assessment of public health to heat-related impacts of climate change in Cyprus

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Population Discomfort

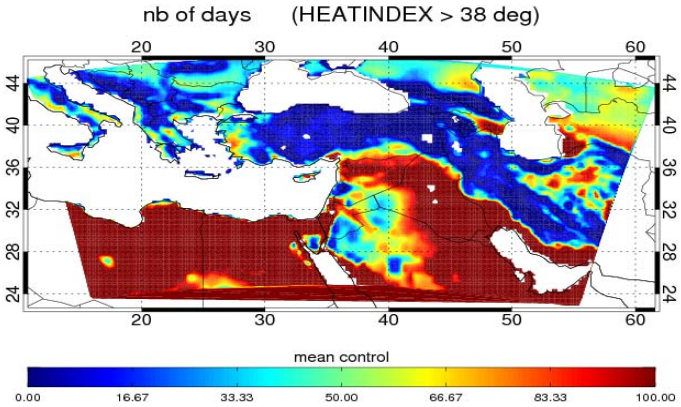
•**Heat effects on human comfort** (**or discomfort**) is assessed by computing the humidex, an index employed to express the temperature perceived by people.

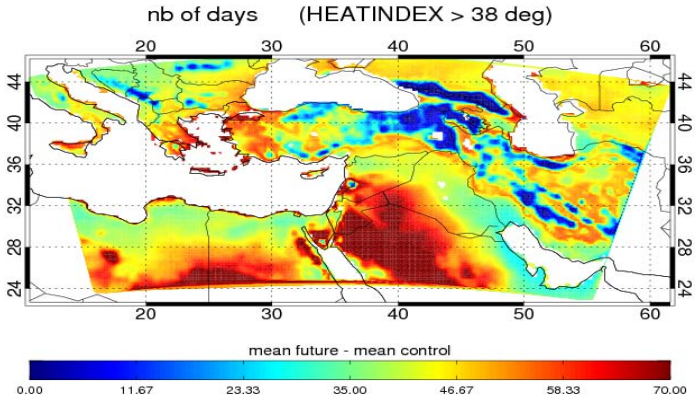
•Humidex is applied in summer and generally warm periods and describes the temperature felt by an individual exposed **to heat and humidity.**

•Six humidex categories have been established, to inform the general public for discomfort conditions:
< 29C: no discomfort
30-34C: some discomfort
35-39C: discomfort; avoid intense exertion
40-45C: great discomfort; avoid exertion
46-53C: significant danger; avoid any activity
> 54C: imminent danger, heatstroke

•Humidex of 38C has been chosen as threshold in this study.

Population Discomfort

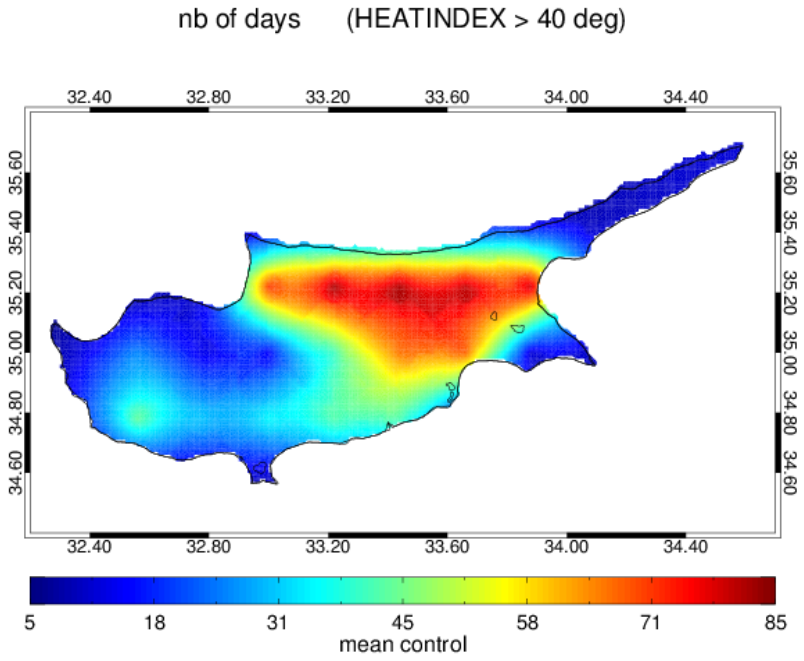




•In the control period, most parts of Greece and Western Turkey have around a month of thermal discomfort days for the population. This value reaches 3 or more months for North Africa and south parts of the Arabian peninsula. Interestingly, coastal and island regions are equally vulnerable.

•For coastal regions in the Eastern parts of Greece, Crete, western/central Turkey and Cyprus, the duration of the period with humidex>38oC is projected to increase by as many as 50 days in 2040-2069. Even larger increases of 70 days are projected for the Arabian peninsula. Smaller changes are evident in mountainous areas (eg. Balkans, Anatolia) i.e. their cool summer climate should be maintained.

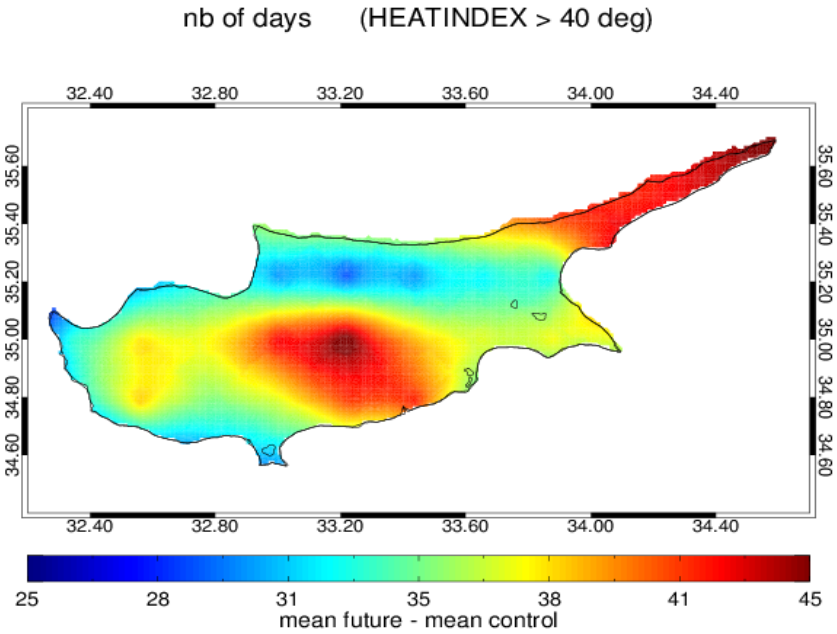
Climate Indices 1961-1990



The continental interior has currently the highest number of discomfort days – around 80

Differences in climate indices: future (2021-2050) - control

Greater increases (more than 1 month) along the south coast and inerior



IS THE INCREASE IN POPULATION DISCOMFORT TRANSLATED TO AN INCREASE IN HEAT-RELATED MORTALITY?

Mortality/temperature relations are examined for the island of Cyprus, using the JUNE-AUGUST months of the observational period 2004-2011.

The ultimate aim will be to use multiple regional climate model output to estimate future daily mortality under a climate change world.

Data Availability

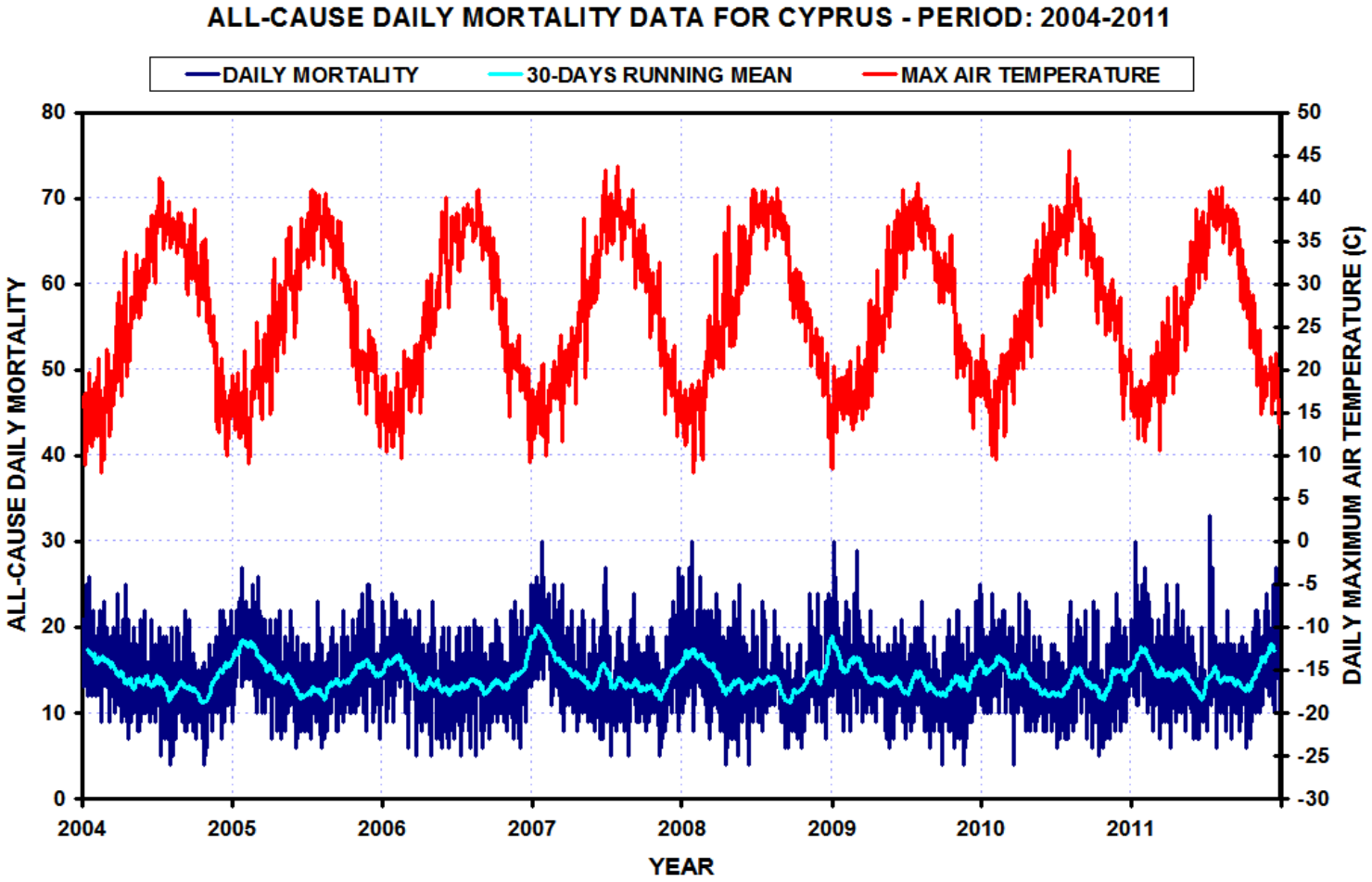
All-cause daily mortality data for the island of Cyprus, covering the period 12004-2011, were acquired.

Source: → Cyprus Statistical Service (Department of health statistics).

Daily maximum temperature data for Nicosia for the same period were also provided

Source: → Cyprus Meteorological Service

All-cause daily mortality data for Cyprus , and for the period 2004-2011.



Seasonal variation of mortality: higher in winter and in summer, lower during transient seasons. There have been considerable heat or cold related deaths in Cyprus.

Calculation of EXCESS DEATHS for summer months

To calculate **EXCESS DEATHS**, i.e. deaths beyond those expected for a specific period in that population:

- Use of a FIXED MEAN of daily mortality for each summer month, for the period 2004-2011 (12.9 deaths for June, 13.4 in July and 13.6 in August).
- Daily excess deaths were calculated by subtracting the expected (fixed mean) from the observed daily mortality values.

Example: for the fixed mean approach, that meant that subtracting 12.9 from every observed daily death for June, 13.4 from every observed daily death of July, and 13.6 from every observed daily death of August.

EXCESS Deaths: Description of Method

- Each number of excess deaths was then grouped into the corresponding 1^{o}C interval of maximum air temperature

Example: if on the 16th of July the maximum temperature was 39.3^{o}C and there were 10 excess deaths, 10 would be put in the 39-39.9^{o}C interval.

- All excess deaths in each 1^{o}C interval for the entire period were added in order to find out where heat-related deaths were no longer detectable. In this way only temperatures over a certain threshold were regressed.

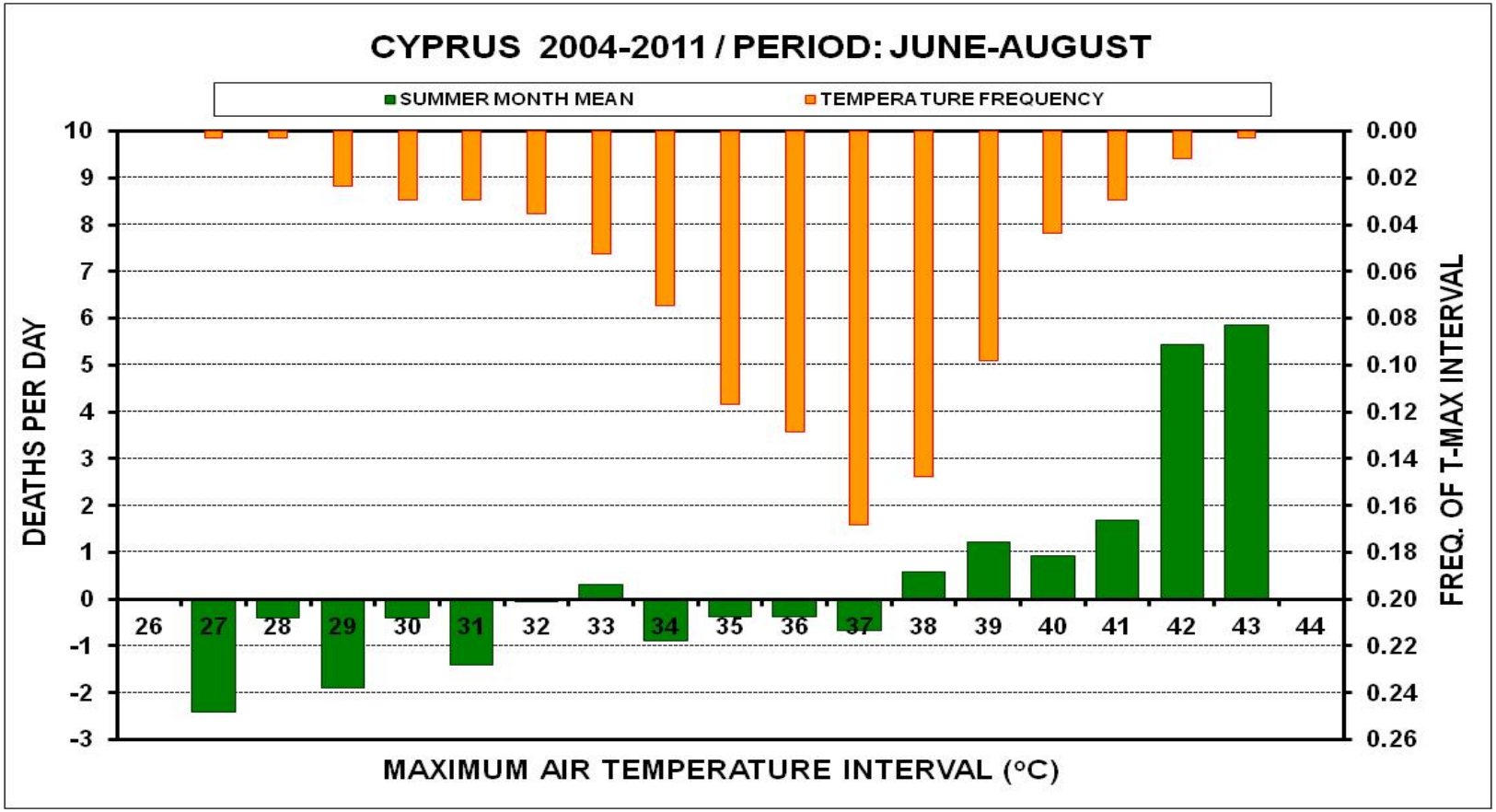
Example: if the maximum temperature on the interval 39-39.9^{o}C was observed 5 times, and the calculated excess deaths were: +20, -15, +12, -7 and +10, then SUM=(+20)+(-15)+(+12)+(-7)+(+10)=20.

EXCESS Deaths: Description of Method

- Finally, the sum of the excess deaths in each interval was divided by the frequency of occurrence of that temperature interval to give the number of deaths per day for a particular temperature interval.

Example: if there were 681 deaths (the sum of all excess deaths negative & positive that occurred) in the 39^{o}C interval (i.e. 39-39.9^{o}C), and the number of times this temperature interval was observed in the period 1992-2006 is 27, then the number of excess deaths per day is equal to 681/27=25.2

Summer Deaths per Day for each temperature interval for Athens, during the period 1992-2006



A fairly linear increase of mortality with increasing temperature and thus high sensitivity is observed - with hotter days associated with greater morality risk.

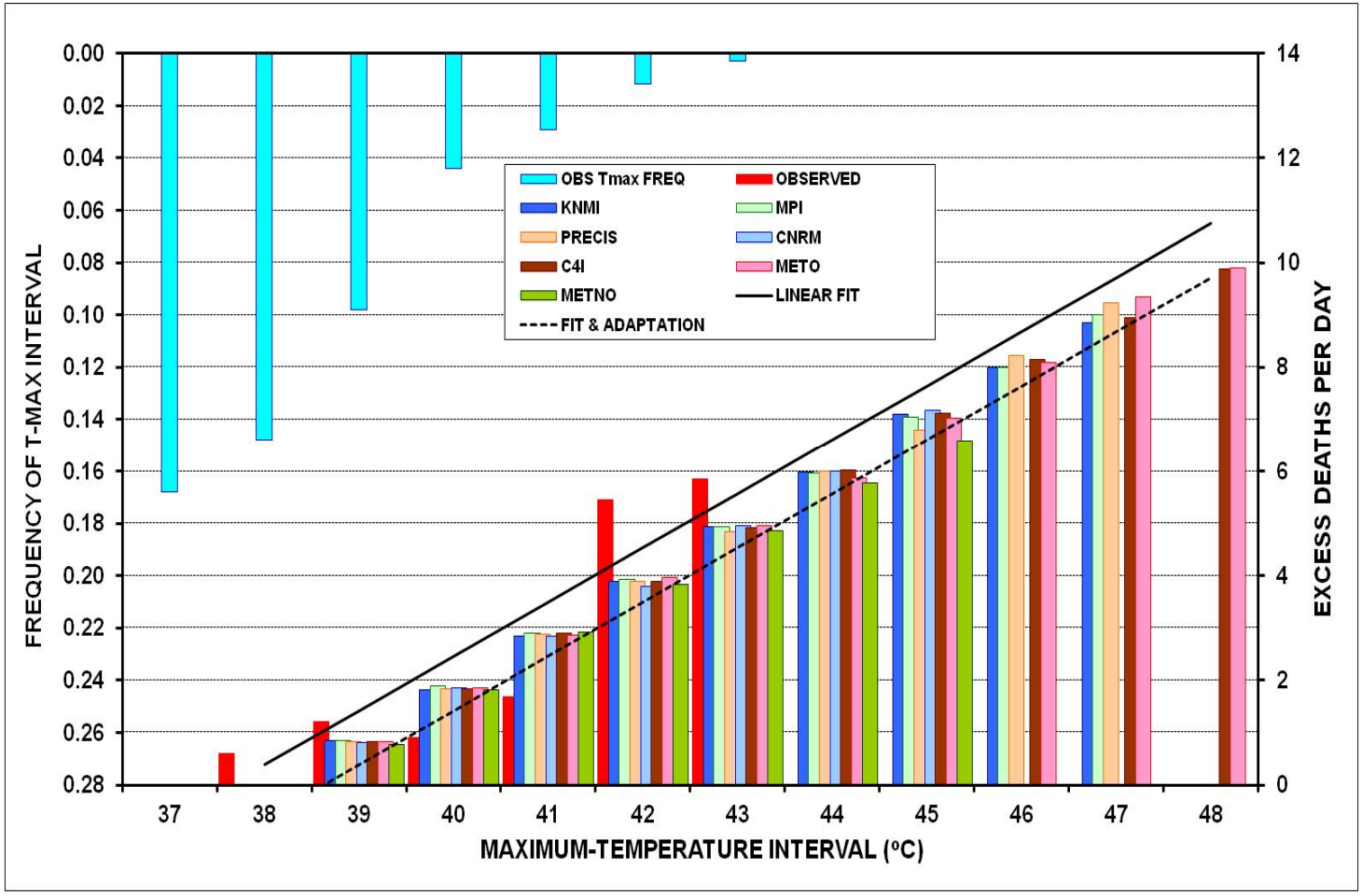
Heat-related deaths start to be discernible when the maximum temperature is 38°C or above.

Future mortality projections using RCM data and Impact Models.

A linear model was used to project heat-related mortality to the future climate of 2021-2050 using temperature output from the PRECIS RCM simulation under the A1B emissions scenario.

An ‘adaptation’ or acclimatisation factor of 1°C per 30 years (meaning that people will adapt to 1ºC temperature increase after a 30-year period) was included to allow for physiological and behavioral adjustment to higher temperatures. The same model was also applied for 6 additional RCMs for the 2021-2050 period.

Climate-Mortality relationship –LINEAR model



There will be an increase of heat related mortality (even after adjustment for adaptation) with up to 10 excess deaths per day under very hot weather conditions

Conclusions

❖ Our study has so far shown that there have been considerable heat-related deaths for Cyprus , especially from extreme heat, during the summer months of 2004-2011.

❖ Significantly increased rates of mortality were projected for 2021-2050 even with an adaptation factor and should be taken into account by governmental health services. Up to 10 excess deaths per day under very hot weather conditions are expected in the near future (with some variations among models)