Boletín de la Asociación de Geógrafos Españoles N.º 69 - 2015, págs. 569-572
I.S.S.N.: 0212-9426

ANALYSIS OF TROPICAL NIGHTS ON THE ATLANTIC COAST OF THE IBERIAN PENINSULA. A PROPOSED METHODOLOGY

Dominic Royé
Alberto Martí Ezpeleta
Departamento de Geografía. Universidad de Santiago de Compostela
dominic.roye@usc.es ; alberto.marti@usc.es

I. INTRODUCTION

Heat waves are a common phenomenon during the summer season in the temperate climates of Europe, especially in the southern regions, most exposed to warm air masses from northern Africa regions. It is a highly variable temporal and spatial phenomenon, which adversely affects the welfare and health of the population. The effects of heat waves on the population have been described by different authors who found clear links between higher temperatures and mortality (Huynem et al. 2001, Diaz et al. 2002, 2006, García-Herrera et al. 2005, WHO 2004). In the last decade it has been observed, globally, a significant increase of these episodes (Coumou and Robinson 2013, Coumou and Rahmstorf 2012).

The most common consequence of the warm nights on health is their impact on sleep and rest of the people. Heat can cause disturbances and sleep deprivation due to processes of thermoregulation (Buguet 2007). Specifically, higher than the comfort temperature can influence sleep loss and the reduction of REM (Rapid Eye Movement) and SWS (Slow-wave sleep) phases (Haskella et al. 1981, Okamoto and Mizuno 2005). Sleep disorders occur more frequently, as the risk of death during heat waves, in people with advanced age (Buguet 2007, Koppe et al. 2004).

The climate change projections show an increased frequency, duration and intensity of heat waves that will affect Europe, with major impacts on the Iberian Peninsula and the Mediterranean regions (Fischer and Schär 2010, IPCC 2014). It is very interesting to have adequate indicators to assess the risk of nocturnal heat impact on the health and welfare of the population. The objective of this work is to apply a methodology to study the hot nights, also called "tropical", in Galicia and Portugal. So can be identify those nights where people can be affected by heat stress.

II. METHODOLOGY

The concept of "tropical night" has been defined as a night when the minimum temperature is greater than or equal to 20°C (Vincent et al. 2005, Alexander et al. 2006, WMO 2009, EEA Report 2012, Donat et al. 2013, DWD 2013). The Expert Team on Climate Change Detection Indices used days with temperatures >20°C as one of the climatic indicators for monitoring climate change (Lisa et al. 2009, Russo and Sterl 2011).

Limitations in the use of high temperature as an indicator of nights at risk of heat stress have led us to propose two new indicators in order to improve the evaluation of this type of thermal risk. In Europe, studies predict an increase in this type of warm tropical nights, like those that have been observed in recent decades (WMO 2009, EEA Report 2012, Olcina 2012, Donat et al. 2013).

To calculate the proposed indicators is necessary to have data sub hours air temperature. The first indicator is calculated by adding the number of night hours in which the threshold is exceeded 20°C. The value obtained is transformed according to the total number of night hours in order to compare the different nights of the year, getting a percentage relative. In this manner we obtain the number of nights that the percentage of hours that have passed this threshold is equal to or greater than 40%. To these nights we call "warm", to differentiate them from the tropical nights, when the threshold of the 20º is reached 100% of the night hours.

The second is an index that assesses the intensity of nocturnal heat stress. It is obtained through the sum of the values during the ten-minute equal with temperatures exceeding 20°; the result is divided by the total length of the night. The whole process has been done with the R-GNU (3.01) statistical system. To calculate the variation of the number of hours between sunset and sunrise, we have used the Sun-methods {MapTools} package, which uses the algorithm of the National Oceanic & Atmospheric Administration (NOAA).

The study area corresponds to the Atlantic coast of the Iberian Peninsula, from Ferrol, north of Galicia, to Faro, southern Portugal. So we can analyze the relationship between the frequency of warm nights and latitude, keeping the Atlantic Ocean as a common geographical factor.

In the case of Galicia we have used ten-minute data from the Galician weather service, Meteogalicia, for the months of May to October. The study period is 8 years, from 2006 to 2013. We have selected the following weather stations: Ferrol, Lugo, Coron (Ria de Arousa), Santiago and Ourense. They have also used the daily minimum temperature data for the period 1981-2013, collected by the State Meteorological Agency (AEMET) and obtained from the data base ACE (Home European Climate Assessment & Dataset). With these data we have analyzed the evolution of the tropical nights in this interval of 33 years.

For Portugal we could only have half-hourly data for Porto, Lisbon and Faro, for the period 2006-2013. They were obtained from the Integrated Surface Hourly (ISH) Dataset, available at the National Climatic Data Center (NOAA).

III. RESULTS

It highlights the low average number of tropical nights in Galicia stations, with values ranging between 0 in Lugo and 1.2 in Coron. However, we must highlight the fact that these tropical nights are a phenomenon characterized by a high temporal variability; in certain

years they recorded up 10 and 12 tropical nights; for example, it is the case of Vigo and Ourense in such hot summers like 1981 and 2003, when there was a intense heat wave in August that caused thousands of deaths throughout Europe. These years with very hot summers alternate with years in which there has been no tropical night and, other, more frequent, in which are produced between 1 and 2 nights.

As with many extreme weather events, the high inter-annual variability is one of its most important features, which detracts from the mean values that mask a more complex reality. There are risk episodes that can affect irregularly the welfare and health of the population.

The low averages of tropical nights in Galicia are also due to the behaviour of temperatures during hot days. These temperatures suffer significant variations, with very high highs in many inland areas (regions of Ourense and Santiago), but with a rapid drop in temperature from the sun. This has the immediate effect of increasing the thermal sensations of freshness by the population following the withdrawal of the sun. This is due to the thick vegetation that consumes a lot of energy in the process of transpiration. This thermal behaviour is very different in the inner cities. The massive use of granite for construction and other urban materials makes lot of heat build-up during the day; cities maintains higher temperatures for much of the night, generating the heat island phenomenon that will increase the number of warm and tropical nights in the inner cities.

This thermal behaviour during hot days is explaining that places like Ourense, with very high maximum temperatures on numerous occasions during the summer (Roye and Martí, 2012), has such a small number of tropical nights when the temperature is low greater than 20 degrees. However, the average number of warm nights is 13.2, reflecting better the reality of summer thermal depression of Ourense, where heat stress is quite common for at least the first half of the night. This behaviour also occurs in inland areas of Galicia, as in the area of Santiago. Here 0.3 tropical nights and 3.2 warm nights are recorded.

The effect of latitude and the greater influence of warm subtropical air masses will be decisive in increasing the risk for heat stress associated with tropical and warm nights. Going down the Atlantic coast the number of warm nights increase steadily and rapidly. Thus, if in Arousa there is an average of 1.2 tropical nights and 6.2 warm nights, in Porto the frequency is 6 and 14.5 nights respectively. In Lisbon a strong rise occurs, with 34 tropical nights and 73.3 warm nights; and in Faro 72 tropical nights and 113 warm nights are recorded.

Analyzing the time series between 1980 and 2013, no significant trend of increased number of tropical nights is observed. It also can be seen in the evolution of warm nights in the last 8 years of the study. What it clearly shows is a high inter-annual variability, which also characterizes the tropical nights

Period with increased risk of warm nights is concentrated between June and September. Months of July and August are those with a greater number of them. It is in these months when they occur more frequently atmospheric conditions of stability and advection mass of warm air from the interior of the Peninsula or North Africa that tend to generate heat episodes (Lorenzo et al. 2008, Martí et al. 2011).

The configuration and intensity of heat islands in cities cause that thermal values in weather stations, usually located on the urban periphery, do not match the real temperatures that residents of urban centers are seeing, as it is shown in Santiago and Ourense. The

warm nights are, therefore, more frequent and intense in the inner city, so its inhabitants suffer greater thermal sensations of stress that can affect your well-being and health.

IV. CONCLUSIONS

With the application of the proposed method of study we have found that a significant number of nights with possible heat stress in the first half of the night is hidden if only taking into account the minimum temperatures as an indicator. If we use sub hourly data we can assess in more detail the thermal characteristics of the nights between May and October, and can more accurately assess the risk to the health and welfare of the population. We must take into account that it is the early hours of the evening and the first phase of sleep which is described as the most sensitive and which accumulates the greatest heat stress disorders.

The analysis results have confirmed a continued increase in the frequency of tropical and warm nights in the Iberian Atlantic coast, from northern Galicia to southern Portugal. The lower latitude and proximity to the coast are directly related to the increased persistence of heat and heat stress during hot nights. In most inland areas, sometimes with more often warm nights, the persistence of heat is lower due to faster cooling temperatures.

North-western Galicia is affected less frequently by masses of very warm air, but when they reach northern latitudes, they are associated with episodes of intense heat, producing warm nights, some of them known as tropical nights. While in more southern regions, with significantly higher minimum temperature, it is not necessary the presences of such extreme warm episodes, to have such tropical and warm nights.