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MONITORING OF EXTREME TEMPERATURES TO EVALUATE THE INTERACTION BETWEEN CLIMATE CHANGE AND HUMAN HEALTH IN COASTAL AREAS

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Abstract: Climate change can affect coastal areas in a variety of ways. These zone are sensitive to sea level rise, changes in the frequency and intensity of storms, increases in precipitation, and warmer ocean temperatures. In addition, rising atmospheric concentrations of carbon dioxide (CO_2) are causing the oceans to absorb more of the gas and become more acidic. This rising acidity can have significant impacts on coastal and marine ecosystems.

High temperatures are increasing in recent years. Extreme weather events, such as heat waves, are one of the hallmarks of global climate change. In light of climate change and rising frequency of extreme weather events, the impact of weather on human health is affecting widely the scientific community. In particular the associations between high temperatures and mortality are well studied. Weather conditions are natural factors that affect the human organism. Recent works shown that the temperature threshold at which an impact is seen varies by geographic area and season.

In this paper, the heat wave-related hospital admissions were analyzed for the summer period (June – August) of 2012, for two city located in Ionian area of Italy: Matera and Policoro. Meteorological variables of the Matera and Policoro measuring stations were retrieved from the regional agency for development and innovation in agriculture (Italian acronym – ALSIA). Starting from these data, bioclimatic indicators were calculated and compared with hospital admissions, in order to identify a correlation with heat waves.

Keywords: heat waves, bioclimatic indicators, climate change, human health.

1. INTRODUCTION

A heat wave is an extended period of extreme climate conditions for a particular region, characterized by high temperatures over average values. These conditions can persist for several days and are worsened by a combination of high humidity and lack of wind, which they are obviously characteristics of the summer period [1].

There exist no universal definitions for a heat wave, as it is relative to a specific area and to a certain time of year. In fact, average temperatures in one region may be considered heat wave conditions in another. However, in the absence of an adequate definition from the WMO (Word Meteorological Organization), it is possible to assess heat wave based on the exceedance criteria of the threshold values of temperature. They are defined by 90th percentile (10%) and 95th percentile (5%) on maximum values detected in a specific area [2].

The average temperature for the European land area for the last decade (2003-2012) is 1.3°C above the pre-industrial level, which makes it the warmest on record. Climate simulations from different regional climate models show that the annual average land temperature over Europe will continue to increase by more than global average temperature during the 21 century. By the 2021-2050 period, temperature increases of between 1.0°C and 2.5°C are projected, and by 2071-2100 this increases to between 2.5°C and 4.0°C. The largest temperature increases during 21 Century is projected over eastern and northern Europe in winter and over Southern Europe in summer. Extremes of cold have become less frequent in Europe while warm extremes have become more frequent. Since 1880 the average length of summer heat waves over Western Europe doubled and frequency of hot days almost tripled [3].

Changes in both the averages and extremes of climate are projected to impact the electric power sector, including effects on electricity demand, supply, and infrastructure. Changes in temperature are likely to alter the level, timing, and geographic distribution of electricity demand. In particular, higher temperatures are projected to increase electricity demand for cooling [4].

Warmer temperatures concern both the higher temperatures in winter that the hot temperatures in summer; in the first case the result is a lower number of days of frost, in the second case it can be determined by a higher intensity of heat waves.

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The impacts of heat waves on human health are widely known. The relationship between extreme weather events and mortality are widely documented in different studies. Heat waves have been increasing in intensity, duration, and frequency. This has led to rising in diseases and mortality, especially for the most at risk population (elderly, children and cardiac patients, etc.) [5]. These phenomena are particularly dangerous in early summer, when the thermal regime of a human body is not completely changed, with a consequent physiological stress [1].
Heat warning criteria should consider local thresholds to account for acclimation to local climatology as well as the seasonal timing of a forecasted heat wave.

The understanding of the association between weather conditions and hospital admissions is very important to evaluate the impact to the high temperature on vulnerable populations, in particular to predict how climate change may increase the future load of heat-related morbidity. A good knowledge of these correlations it's essential to refine activation thresholds for Heat Health Watch Warning Systems. Many studies examined associations between heat waves and hospital admissions, obtaining different results [6]. For example, Kovats et al. (2004) [7] in the 1995 summer, in London, they found an association between heat wave and respiratory and renal diseases, and increased mortality; but not associated with hospitalizations. On the contrary, heat waves, in Australia, have been associated with increased hospitalizations but not increased mortality. A study, conducted in 12 European cities, showed an respiratory admissions increased with temperature in Mediterranean and North-Continental areas. Moreover, cardiovascular admissions tended to be negative and non significant [6].

The present study aimed to examine the short-term effects of air temperature on daily hospital admissions for the summer period (June – August) of 2012, due to diagnosis related to the effect of heat waves for two cities of Basilicata Region (Southern Italy) located in Ionian area: Matera and Policoro.

2. DATA AND METHODS

The majority of researchers who analyze the associations between human health and weather variables, investigate the effect of air temperature and bioclimatic indices. These indices combine air temperature, relative humidity, and wind speed, and are very important to determine the human thermal comfort. Health impact studies of weather events showed that the prevention is an essential element to dramatically reduce the impact of heat waves.

This work examines the interactions between heat waves and the daily cases with diagnosis-related hospital admissions in two cities, Matera and Policoro, in the June-August 2012 period. For the evaluation of heat waves were examined the following bioclimatic indicators: Apparent temperature (AT), Scharlau Index (IS), Relative Strain Index (RSI), Humidex Index (HUM) [8, 9, 10, 11].

Italian summer 2012 was characterized by high average temperatures (with +2.3°C, in reference to the period 1971-2000), enough to be considered as the second hottest summer since 1800; after summer 2003 (with +3.7°). Three principal heatwaves in 2012 occurred:

1. The first heatwave between the 17th and the 23th of June, with apparent temperatures which have reached 38ºC, much more in central Italy, with high values until to the end of the month.
2. The second heatwave between the last days of June and the first days of July, with apparent temperatures to 39°C. All July month was characterized by hottest temperatures, with other similar waves bringing to increase the total duration of time waves.
3. The third heatwave was the most intense; it is occurred in the third week of the month of August, with apparent temperatures to 40°C.

In the present work, daily hospital admissions between June 1 and August 31, 2012 were collected from Italian emergency rooms for the two considered hospitals.

Grouped health information (number of emergency hospital admissions on each day) were used. For each patient they include the following data: sex, age, residence zone, day and hour of hospital admission, ward type, diagnosis and triage. The total number of patients admitted to emergency in the three months investigated is 7895 for Matera and 5606 for Policoro.

The heat-related illnesses are usually referable to following symptoms: fever, headache, myalgia, dehydration, palpitations, dizziness, tachycardia, syncope, etc.

The selected cases considered represent the 13% for Matera and 6.8% for Policoro, on the total admissions.

Meteoclimatic data on hourly air temperatures (°C), relative humidity (%), rainfall (mm), radiation (kJ/mq), wind speed (m/s), maximum wind speed (km/h), wind direction [grad] and ground temperature (°C), during the same period, were obtained from two weather stations (Matera Nord and Policoro Pantano) managed by regional agency for development and innovation in agriculture (Italian acronym – ALSIA).

3. RESULTS

Table 1 shows the only patients selected for the diagnosis related to heat-wave effects in the two emergency departments, distributed in the three different months of the examined period.

It is possible to see that not are large variations in the gender, for the total and selected patients (Table 2). For both hospitals, the percentage for selected cases increases for women (+2.1%) and decreases for men (-2.1%). Furthermore, it is possible to note (Figure 1) that the distribution of hospital admissions for the summer months is homogeneous for Matera, instead Policoro presents a greater percentage (+4) in July and lower in June (-6).

Emergency room	June	July	August	Sel. case	Mean Age
Matera	330	378	371	**1079**	45.2
Policoro	96	149	135	**380**	41.2

Table 1 - Selected data emergency department for Matera and Policoro Hospital, June to August 2012

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In table 3, for each hospital, the number and the relative percentage for triage are summarized. Triage is the process of determining the priority of patients' treatments based on the severity of their condition (triage 1 correspond to maximum priority, triage 6 correspond to minimal priority).

	Matera		Policoro	
	Tot. case	Sel. case	Tot. case	Sel. case
Man	52.3%	50.2%	52.6%	50.5%
Woman	47.7%	49.8%	47.4%	49.5%

Table 2 – Percentage of man and woman for the total and selected case

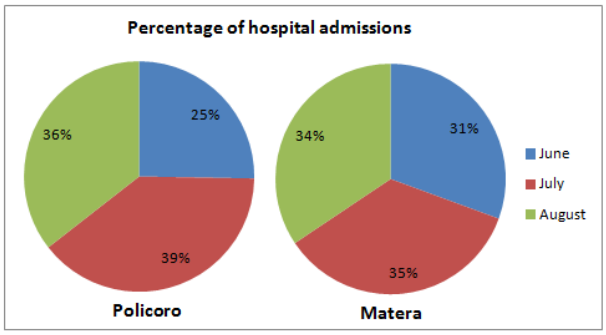

Figure 1 – Percentage of hospital admissions distributed in different months for selected cases of Matera and Policoro

	Matera		Policoro	
Tr1	0	0%	0	0%
Tr2	23	2.1%	3	0.8%
Tr3	281	26%	40	10.5%
Tr4	701	65%	325	85.5%
Tr5	70	6.5%	12	3.2%
Tr6	4	40%	0	0%

Table 3 - Number and percentage of selected patients for triage

For the selected cases in both cities, the most sensitive population is represented to the elderly (>60 years) with about 40% of total patients. On the contrary, the range consist by teenagers (10-19 years) not has suffered by the effects to high temperatures (with about 6%). (Figure 2)

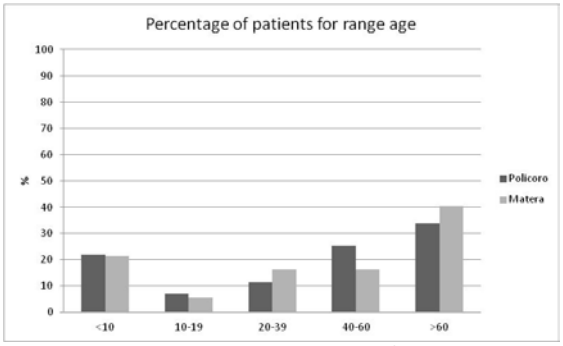

Figure 2 - Emergency distribution for range age

Figures 3 and 4 show the distribution of the number of patient for diagnosis related to heat-wave effects, divided by gender.

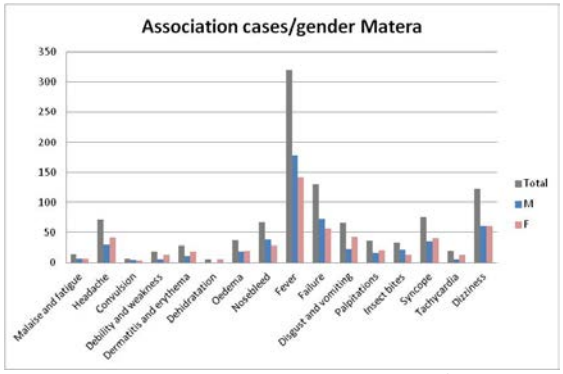

Fig. 3 – Association to disease and gender for the selected cases of Matera Hospital

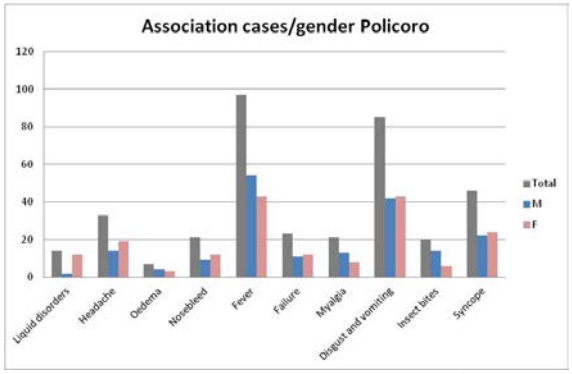

Figure 4 - Association to disease and gender for the selected cases of Policoro Hospital

It is possible to highlight that the symptoms more prevalent for both examined cases, are headache, fever, disgust and vomit, syncope, failure, dizziness and nosebleed. Namely, the more closely heat-related effects. Generally, in the selected cases there are not substantial differences for gender. Only the headache symptom is most present in women that in men, for both hospitals. On the contrary, the fever symptom is preponderant in the men patients.

Policoro presented results not significant, due to sample unrepresentative; therefore, only the correlations between bioclimatic indices and hospital admissions for Matera are shown in this paper. Bioclimatic indicators, defined in paragraph 2, were calculated by weather data for both stations: AT, IS, RSI, HUM. Below the graphs that presenting the trends of these indices compared to selected cases for Matera hospital, in summer period 2012.

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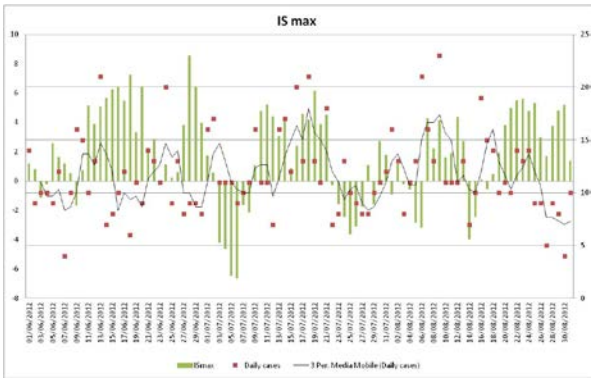

Figure 5 - The hospital admissions for selected cases and the ISmax index during the summer 2012 in Matera.

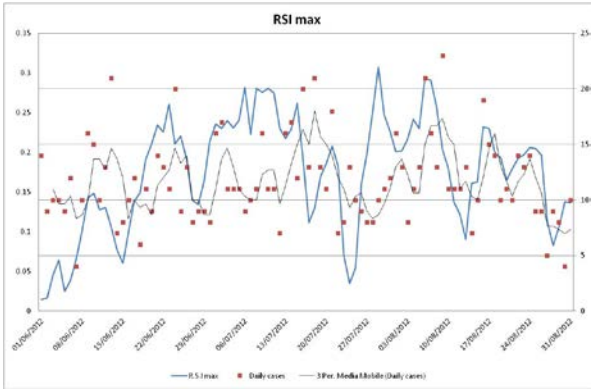

Figure 6 - The hospital admissions for selected cases and the RSImax index during the summer 2012 in Matera.

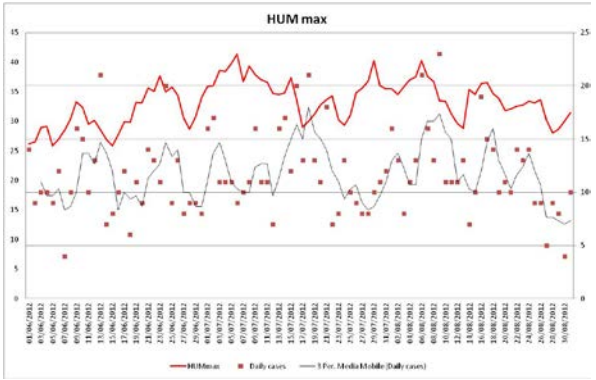

Figure 7 - The hospital admissions for selected cases and the HUMmax index during the summer 2012 in Matera.

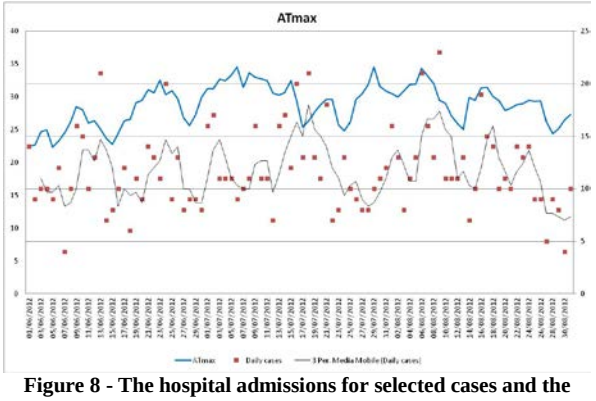

Figure 8 - The hospital admissions for selected cases and the ATmax index during the summer 2012 in Matera.

4. CONCLUSIONS

This study assessed the impacts of higher temperatures, typically related to heat waves, on the hospital admissions for Matera and Policoro cities.

For both cities, gender and age not presented significant evidences for analysis. The case/gender association showed a prevalence of heat-related diagnosis, for the examined period.

The IS index showed the maximum relationship with selected cases in the period half July - half August, therefore in correspondence with the four peaks of temperatures.

All indices present a good correlation with selected cases. In particular RSI, HUM and AT showed a relationship between each index and selected cases in correspondence of three heat waves occurred in Italy in 2012.

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