

ANALYSIS OF TOURISM POTENTIAL FOR CRETE**A. Matzarakis¹, P. Nastos², N. Karatarakis³, A. Sarantopoulos³**¹**Meteorological Institute, University of Freiburg, Germany**²**Laboratory of Climatology and Atmospheric Environment, University of Athens**³**Hellenic National Meteorological Service, Athens, Greece****Abstract**

To describe the tourism potential of an area, not only single meteorological parameters have to be taken into account, but also thermal sensation and people's thermal comfort. The latter can be estimated by the use of human energy balance models and the derived thermal indices, which comprise all relevant meteorological parameters like air temperature, air humidity, wind speed, and short and long wave radiation fluxes.

First, this paper makes an attempt to assess and analyze climatological parameters and the thermal comfort of Crete, its variations and trends for the period of time 1955-2001. Second, a definition and quantification of the island's tourism potential is attempted.

Long term data from several stations are used from the existing climatic and synoptic network of Crete, including daily mean, maximum and minimum temperature, relative humidity, wind speed, and cloud cover over the whole island, in order to derive the daily Physiological Equivalent Temperature (PET) and precipitation. In addition, possible trends of thermal comfort and precipitation on an annual and seasonal basis are analyzed.

Additionally, data of the 10-minutes climatology of the Climate Research Unit of the University of Norwich have been processed in order to create high resolution (1 km) mean monthly maps for climatological parameters such as air temperature, precipitation and Physiological Equivalent Temperature.

Tourism, climate, bioclimate, Crete

1. Introduction

Crete, the biggest island of Greece, located in the eastern Mediterranean, is the most frequently visited Greek island by foreign visitors (about 2 millions people) throughout the year. Tourism represents a major economic factor for Crete. Crete is the most important tourism destination in Greece. The number of overnight stays in Crete accounted for 26.7 % of the overall Greek tourism market in 1999. In 2003 the number of arrivals in Crete reached 642.757 during the first six months, while the corresponding overnight stays reached 4.219.738. Most of the arrivals (91.2 %) were recorded from April to December, while only 8.8 % of arrivals were recorded from January to March. So, in general, information on weather and climate/bioclimate are required for the quantification of the existing climate conditions on the one hand, and for the approximate calculation of possible implications and risks to human health resulting from extreme weather events on the other.

Because of its location in the eastern Mediterranean, the island of Crete has a mild climate with only slight variations. Also due to its geographic location, Crete is protected from the cold air masses of central and western Europe in winter, and the high temperate air masses of North Africa in summer. Thus, the climate of Crete is temperate to maritime, except for most mountainous areas, where is mountainous. Crete has a very pleasant and healthy climate. The winters are mild, particularly in plain and coastal areas. In summer, air temperatures are rather pleasant due to the sea breeze and etesian winds (northerly winds from the Aegean Sea). In winter, the plains and coastlines areas of Crete, and particularly its eastern parts, are some of the

warmest areas of the country. This is due to increased sunshine, scarce snowfalls and absence of frost (Meteorological Office 1962).

First, this paper assesses and analyses the thermal sensation and general climate factors of Crete as well as their variations and trends for the period of time 1955-2001. Secondly, it was attempted to define and quantify the tourism potential of the island.

2. Methods

In order to quantify the tourism climate conditions, long term data from several stations of the existing climatic network of Crete were used, including daily mean, maximum and minimum temperature, relative humidity, wind speed, and cloud cover over the whole island. From these parameters, the daily Physiological Equivalent Temperature (PET) was derived (VDI 1998, Höppe 1999, Matzarakis et al. 1999). In addition, possible trends of thermal comfort on an annual and seasonal basis and precipitation were taken into account.

Also, geo-statistical methods have been applied and available climate data from the 10-minutes climatology (New et al. 1999, 2000) have been used to create high resolution maps of basic climatological parameters and the Physiological Equivalent Temperature for the period of time 1961 - 1990.

3. Results

The analysis of the tourism climate and tourism potential has been analysed through ombrothermic diagrams for the seven climate stations and their corresponding periods. Fig. 1 shows the ombrothermic diagram for Souda/Chania for the normal period 1961 – 1990. With regards to air temperature variations in Crete, the data shows that in the first (cold and rainy) period from October to March, the coldest months are January and February. The mean minimum air temperature in these months varies between 7 - 9 °C in coastal areas, 4 - 6 °C in the mainland, and even lowers values in the highlands (Fig. 1). In general, in this period, the eastern plain parts of Crete along with Dodecanese (the most south-eastern islands of Greece), are the warmest areas of Greece.

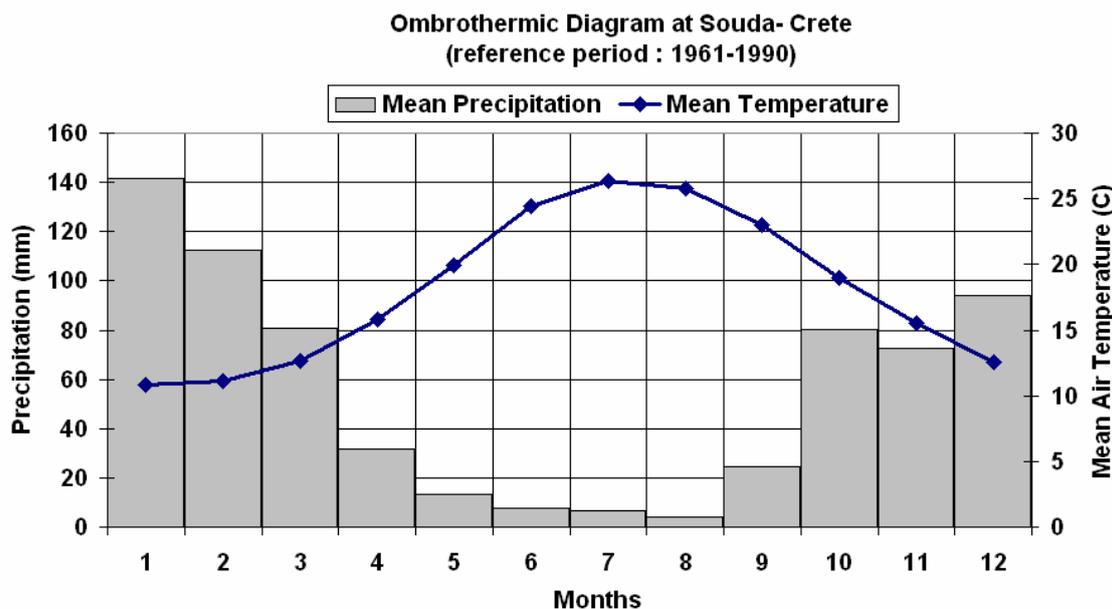


Figure 1. Ombrothermic diagram at Souda/Chania for the climate period (1961-1990).

For each station the thermal human-bioclimate conditions, described through mean conditions, extremes and frequencies of thermal perception classes, were analysed. Fig. 2 shows the bioclimate diagram for Heraklion for the period 1955 – 2001. The thermal human-bioclimate conditions are expressed in percentages of the occurrence of classes for ten day intervals (dekas). Results presented in Fig. 2 show that 50 % of the days from the 11th dekas to the 30th dekas are in the PET-classes of 18 °C and above. It has to be mentioned that the results of Fig. 2 are based on daily mean values for the meteorological variables. From the 13th to 27th dekas also extreme thermal stress can also be observed for the investigated region. Additionally, the mean PET, the absolute maximum and minimum value and also the frequencies of cold days (days with PET < 10 °C), thermal comfort and slight stress days (days with PET between 15 and 25 °C) and days with heat stress (days with PET > 35 °C) are presented in Fig. 2. Fig. 3 shows the seasonal, annual, and tourism period values of PET for the period of time 1955 – 2001 in Heraklion.

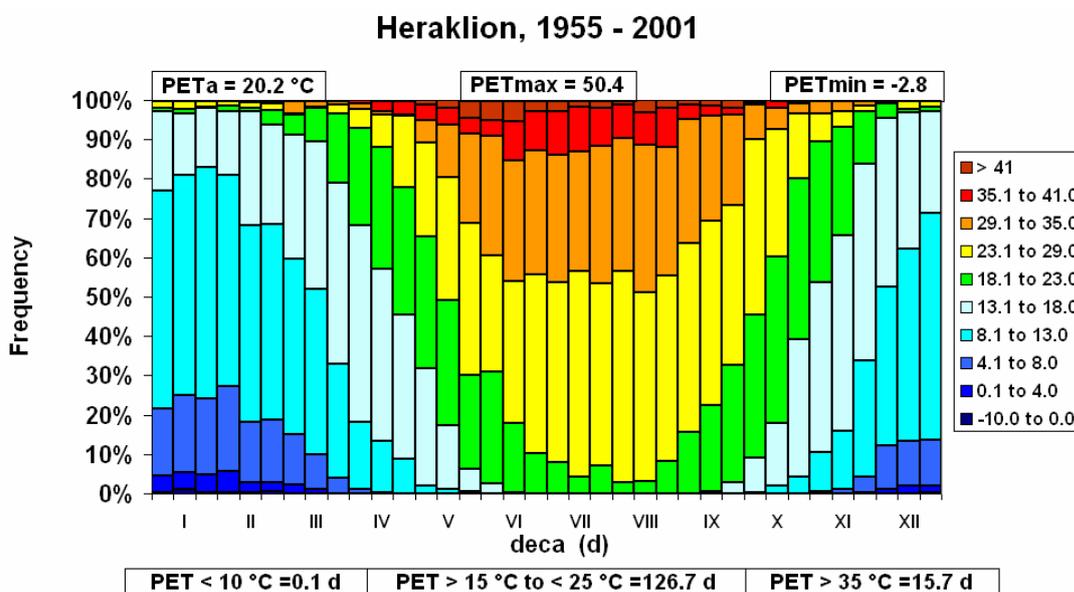


Figure 2. Bioclimate diagram for Heraklion, Crete for the period of time 1955 – 2001.

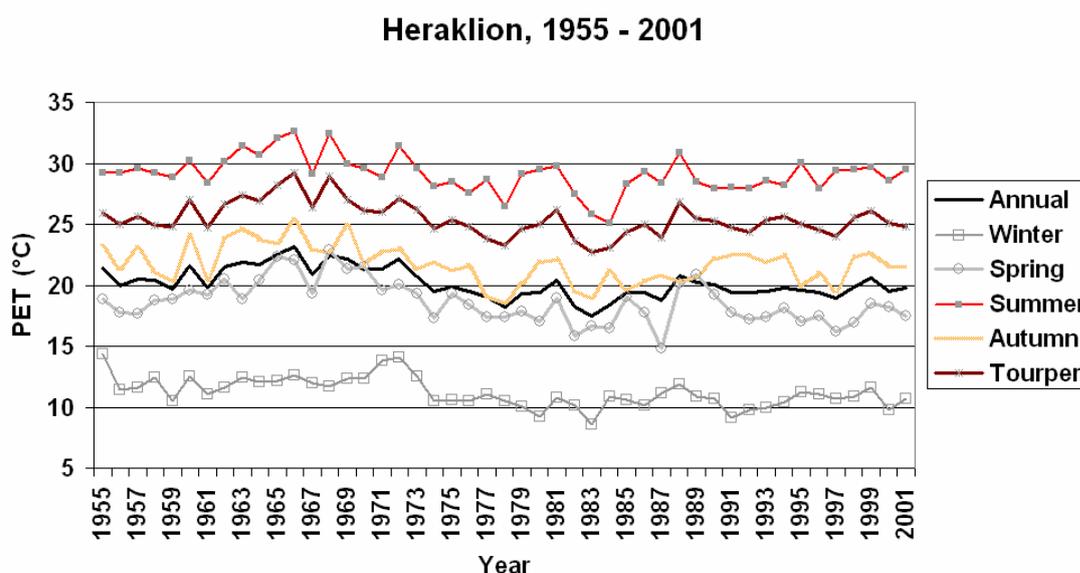


Figure 3. Seasonal, annual and tourism period development of PET for Heraklion, Crete for the period of time 1955 – 2001.

The second (warm and dry) period from April to September is characterised by almost no precipitation and slightly hot air temperatures. The warmest months of this period are July and August. The mean maximum air temperature in these two months varies between 28 and 32 °C, sometimes reaches 34 - 36 °C and scarcely, mainly in southern Crete, approaches 40 °C, particularly in plain mainland areas. These high air temperatures in the southern part of Crete are associated with low air humidity and, thus, the thermal comfort conditions in these areas are still tolerable. June shows about the same temperature regime as September, with the later to be considered as a summer month in Crete. The precipitation increases from East to West and from the northern coastal areas and southern parts to the inland regions and the highlands. In the mountainous areas of Crete, maximum annual precipitation levels of 1100 – 1200 mm are observed. Even higher levels (1600 mm) are observed in the Lefka Ori mountain range (western part). The lowest annual precipitation levels of about 500 mm or less are recorded in the southern parts of Heraklion Prefecture (central part), particularly in the Mesara plain and Viannos area. Snow only falls in the mountains, mainly in the Lefka Ori Mountain range (west part) and the Psiloriti Mountain range (central part), while in the lowlands and coastal areas snowfall is a sporadic phenomenon.

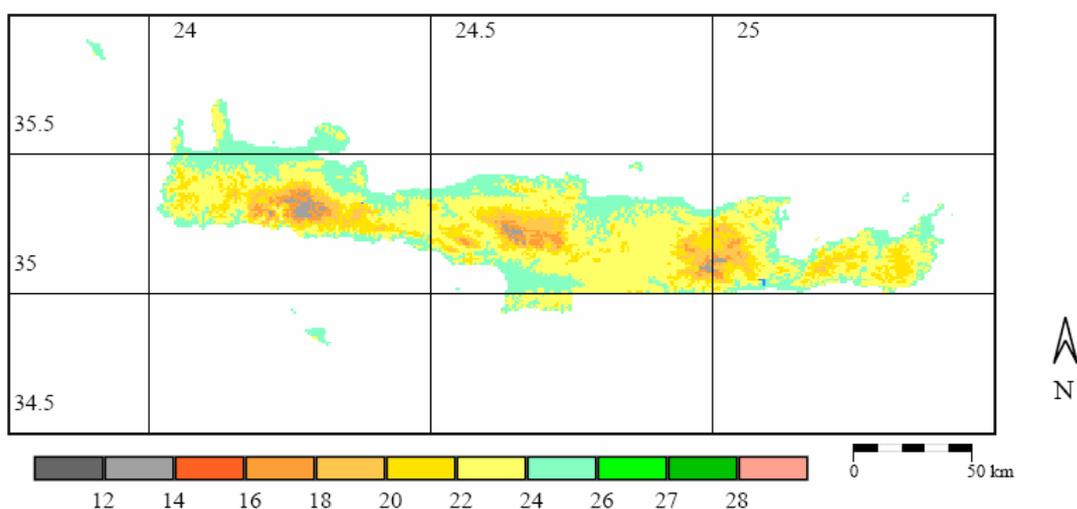


Figure 4. Map of air temperature (°C) for Crete for summer (June, July and August) for the normal period 1961 – 1990 (resolution: 1 km).

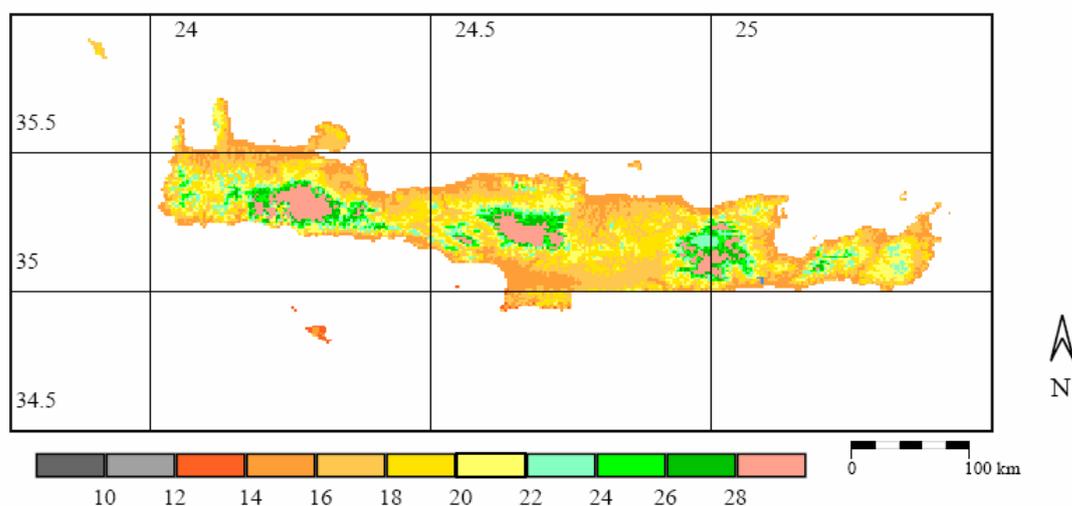


Figure 5. Map of number of days with precipitation (> 1 mm) for the tourism period (April to October), for the period 1961 – 1990 (resolution: 1 km).

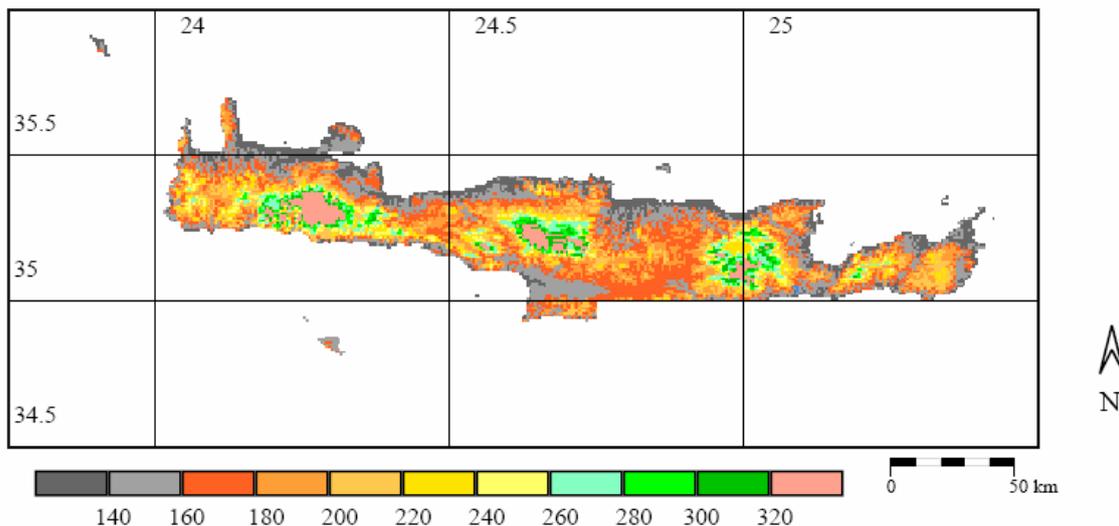


Figure 6. Map of sum of precipitation (in mm) for the tourism period (April to October) for the period 1961 – 1990 (resolution: 1 km).

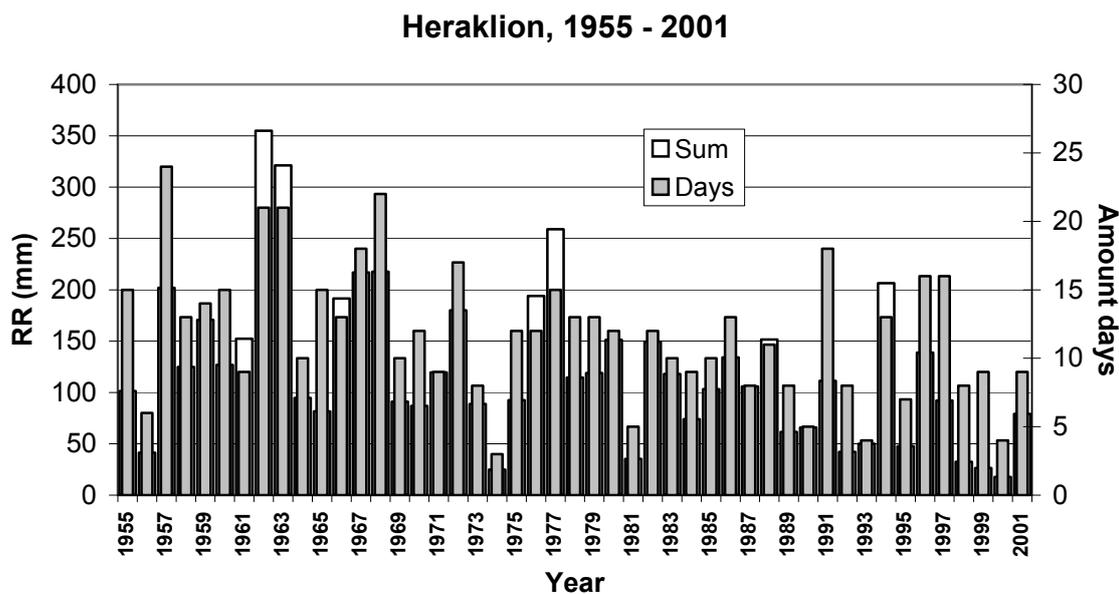


Figure 7. Sum of precipitation in mm and amount of days with precipitation (> 1 mm) in Heraklion for the period 1955 to 2001.

Fig. 4 shows the distribution of air temperature for summer (June, July, August) in a horizontal resolution of 1 km, which represents the spatial variation of air temperature conditions for the whole island fairly well. Except for the air temperature as a common climatic parameter, in terms of precipitation, it is not only important to consider the precipitation sum for the whole year, but also the sum of precipitation during the tourism period as well is analysed. An analysis of the number of days with rain (> 1 mm) provides more useful information for the tourism period. Fig. 5 shows the number of days with precipitation for the tourism period in Crete (April to October) for the normal period 1961–1990. Fig. 5 demonstrates that the number of days with precipitation is generally low, with less than 15 days for the areas of low altitude.