# Variations of thermal bioclimate and its influence to the tourism in the Lake Balaton Tourism Region (Hungary)

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## 1. INTRODUCTION

Tourism is the most important branch of the service sector in Hungary. According to the Hungarian Tourist Authority, tourism in Hungary adds up to 8.7% of the GDP and 12% of the number of employees. Higher rate can only be finding in Mediterranean countries. Therefore it is important to provide satisfactory climatological information to this considerable economic sector.

Lake Balaton (or "Hungarian See" as the Hungarians call) is the largest freshwater lake in Central-Europe and represents one of the greatest environmental treasures and a unique ecological fortune of Hungary. The Lake Balaton's surface is about 600 km$^{2}$; it is 77 km long and 14 km wide at its largest width. The deepest point of the lake is 11 m, but its average depth is only 2 to 3 meters. Its popularity results from the lake's favourable climate, its warm water in summer, and the nice landscape surrounding the lake. The Lake Balaton Tourism Region [LBTR] is part of three counties, three different statistical regions and involves 41 settlements situated right on the lakeside and 123 nearby. The total area of the LBTR is 3780 km$^{2}$.

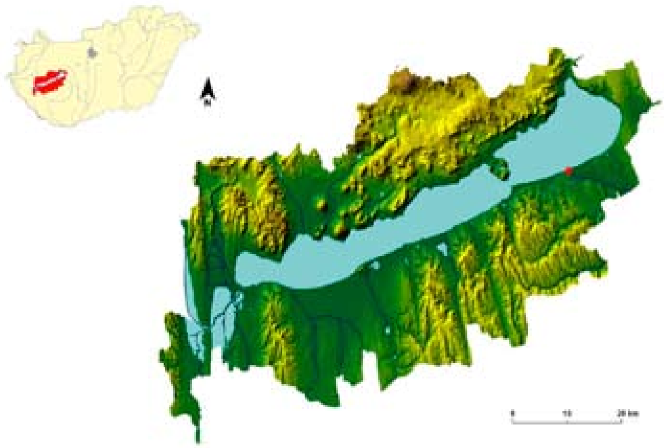

**Fig. 1.** Location of the Lake Balaton Tourism Region

Although the LBTR is one of the most important tourism regions of Hungary its climate has been studied last time at the 70's (Béll and Takács, 1974). From the beginning of the 2000's the tourism of the LBTR went through a crisis. Because of the consecutive hot and dry years, water level of the lake decreased significantly, resulting in relatively large lands coming out of water in the southern coast. Some people visioned even about the total drying up of the lake. Even though the water-quality didn't fall off, more and more people chose the Adriatic and Aegean coast for their holidays instead of the Lake Balaton. This process turned our attention to the impact of the climate change on the lake's tourism. Previously, only conventional climatic parameters (air temperature and precipitation) have been examined in Hungary in connection with tourism. At the Climate Division of Hungarian Meteorological Service, in 2005 have been suggested that should examine the thermal bioclimate of this region, and the variation of it (Németh et al, 2007).

## 2. METHODS

For analyzing the thermal bioclimate we applied the physiologically equivalent temperature (PET), the well-known and one of the most frequently used bioclimate thermal index based on the human energy balance models (Höppe, 1993; Höppe, 1999; Matzarakis et. al, 1999). For calculating PET we used the RayMan model (Matzarakis et. al, 2007; Matzarakis and Rutz, 2005). For the calculation four meteorological parameters (air temperature, relative humidity, wind speed and cloudiness) as well as some standard physiological parameters (age, genus, bodyweight and height, average clothing and working) are required. We calculated the daily PET series (at 12 UTC) for the period 1961 – 2007.

For calculating the PET we used the hourly data series (for selected hours) of the Siófok synoptic station (46°54' N and 18°02' E; elevation: 108 m as l). As this station operates continuously at the same place since the end of the 50's, we considered this data series as homogeneous and accepted it without reservation.

## 3. RESULTS AND DISCUSSION

According to the 47-year mean annual and seasonal PET the thermal bioclimate of the Lake Balaton area is slightly cool (PETa = 14.1 °C), with very cold winters ($PET_{winter}$ = -0.9 °C) and slightly warm summers ($PET_{summer}$ = 28.4 °C). This 47 years include two standard climatological periods, 1961-1990 and 1971-2000. As compared with yearly and seasonal means of these periods we cannot find difference between the yearly mean ($PETa_{61-90}$ = 14.0 °C, $PETa_{71-00}$ = 14.1 °C). As opposed to this the summer mean of PET increased with 0.5 °C ($PET_{summer, 61-90}$ = 27.8 °C, $PET_{summer, 71-00}$ = 28.3 °C).

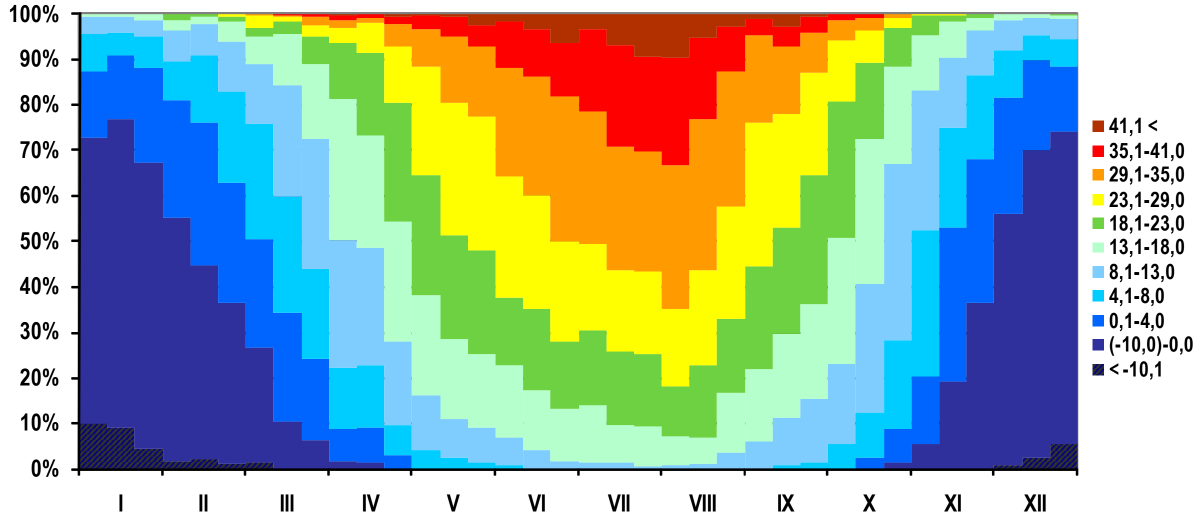


**Fig. 2.** Bioclimate diagram for Siófok, period 1961-2007

The bioclimate diagram (Fig. 2) illustrate thermal bioclimate information on percentages of different bioclimatic classes of PET, plotted in ten-day intervals during the whole year and based on 47-year data series for 12 UTC. The lowest PET values were in January; this corresponds with the lowest air temperatures. The highest values of PET were in beginning of August, although the warmest month based on the air temperatures is July.

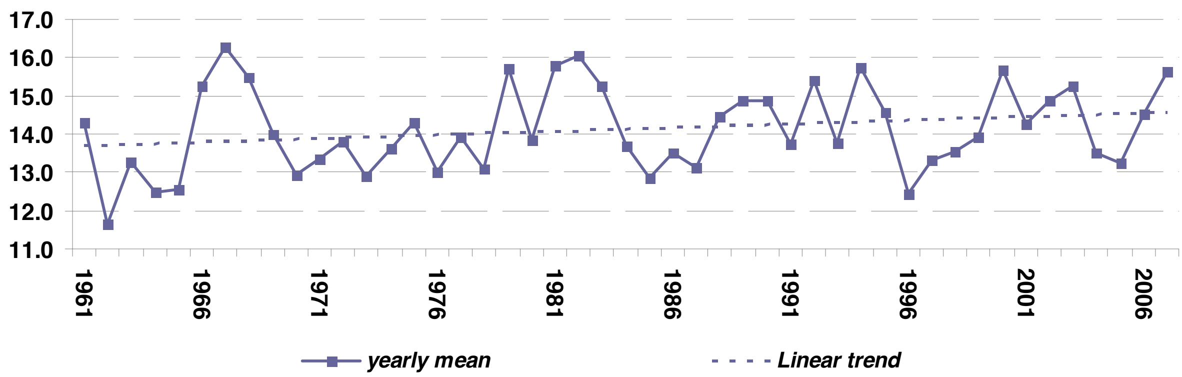


**Fig. 3.** Mean annual values of PET at 12 UTC and the linear trend for Siófok, period 1961-2007

According to the linear trend the annual mean of PET (Fig. 3) increased by 0.9 °C in the examined 47-years period. The annual change was 0.02 °C only, but the warming was not consistent during the observed 47 years.

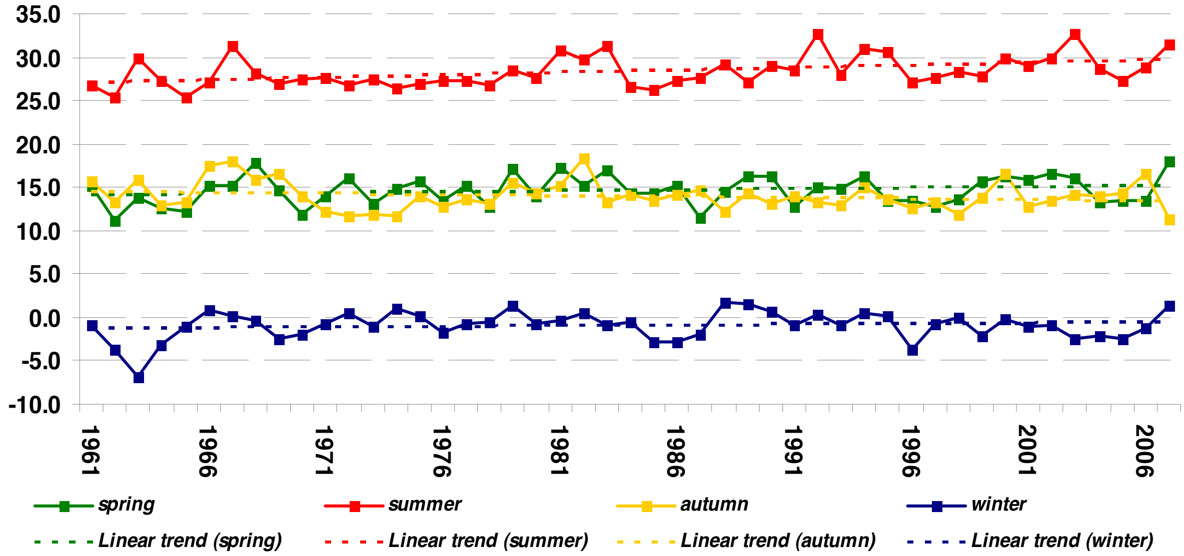


**Fig. 4.** Mean seasonal values of PET and linear trends for Siófok, period 1961-2007

The variation of seasonal means of PET (Fig.4.) shows some very interesting characteristics. The greatest increasing is in summer. This trend means more than 0.05 °C per year, which is 2 to 4 times bigger than in other seasons (0.02 °C per year in spring, 0.01 °C per year in winter). In autumn the seasonal mean of PET decreases 0.02 °C per year.

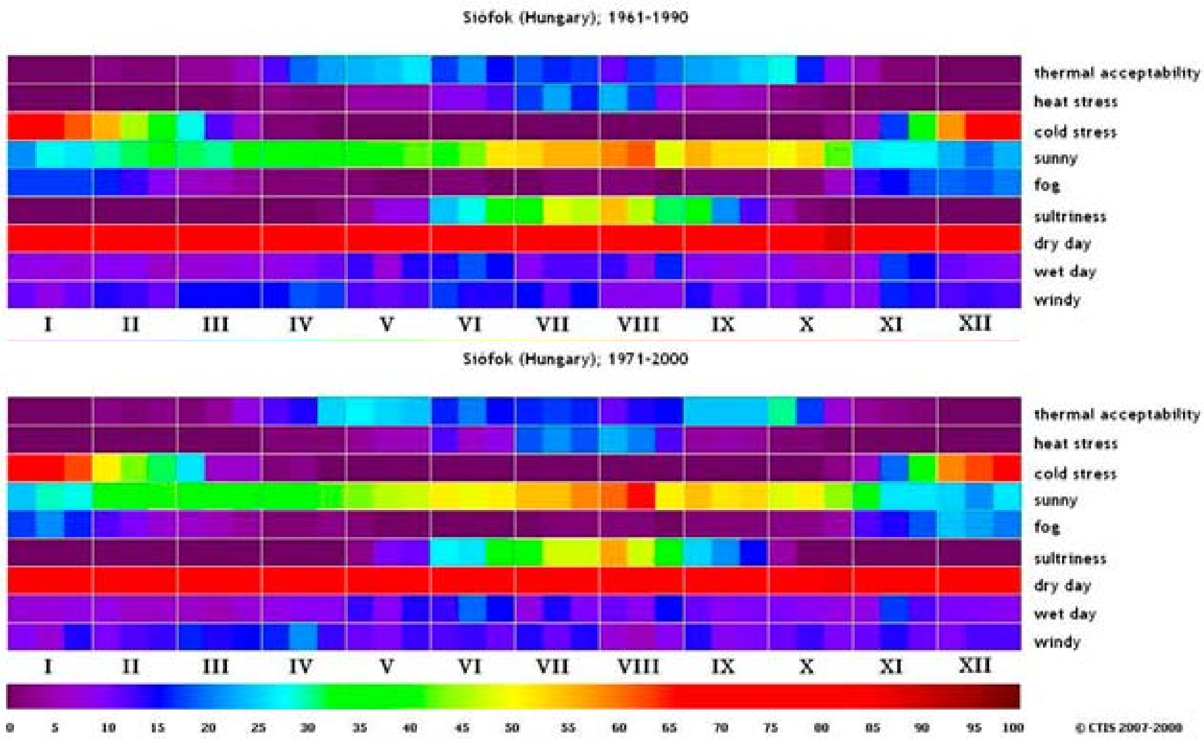


**Fig. 5.** Climate Tourism Information Scheme for Siófok, period 1961-1990 (upper) and 1971-2000 (lower)

One of the newest tools, the Climate Tourism Information Scheme (CTIS) based some thermal, physical and aesthetical aspects (Fig. 5) has been applied (Lin and Matzarakis, 2008, Matzarakis et al. 2007). The thermal aspects include thermal acceptability (PET between 18 – 29 °C), heat stress (PET

> 35 °C) and cold stress (PET < 0 °C). The physical aspects include sultriness (when the vapour pressure more than 18 hPa), dry day (precipitation < 1 mm) and wet day (precipitation > 5 mm) and windy parameter (wind speed > 8 m/s) and the aesthetical aspect include for example sunshine (cloudiness < 5 octas) and fogy (relative humidity > 93 %). Compared to the CTIS for period 1961-1990 and 1971-2000, some difference can be found. The number of sunny days increased in summer. The number of wet days decreased in summer on the whole.

## 4. CONCLUSION

Tourism sector (including decision makers, tourism industries and tourists) need accurate climatological information for their decisions. The long time planning needs not only the actual weather conditions, but some information about the natural and man made changing of climate. We analyzed the variation of thermal bioclimate of the Lake Balaton Tourism Region. According our results the climate and the bioclimate will warmer more and more. It may be hypothesized, that this variations affect the tourism potential of this region directly and indirectly alike. First of all, the length of tourism season will be longer. On the other hand, the Lake Balaton allures more tourists, if the Mediterranean area will be too hot. However it is a positive economic scenario, it means some environmental risks (e.g. air pollution by the growing vehicular traffic, water contamination by bathers, etc). Besides this, the changing climate necessitates some basic investments (eg. air conditions in the hotels or in the public conveyances).

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