Evaluation of climate from the point of view of recreation and tourism

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1. INTRODUCTION

Climate information provided to tourists and tourism industry should include not only its general features (mean monthly and annual values of particular climate elements) but also detail information regarded to thermal comfort as well as aesthetic and physical weather factors (de Freitas, 2003, Matzarakis et al., 2004, 2007a, b, VDI, 1998). All of these factors have to be included in an integrated assessment of tourism climate (Matzarakis, 2007). The aim of the paper is to present recent concepts of tourism climate evaluation based on analysis of actual weather. Multiannual meteorological daily data for various stations over Europe is used for this purpose.

2. METHODS AND DATA

Two assessment methods will be applied: the Climate-Tourism-Information-Scheme (CTIS) (Matzarakis, 2007) and the Weather Suitability Index (WSI). Both methods will assess weather components with ten-days intervals.

Climate Tourism Information Scheme (CTIS)
An integral possibility for the assessment of weather and climate information for applied purposes, a.e tourism, allowing detailed description is the Climate-Tourism-Information-Schemes (CTIS) (Matzarakis, 2007). CTIS is based on frequency distributions of parameters and values. Relevant and important bioclimatological and climatological parameters are integrated in this scheme and shown in percentages of occurrence or not occurrence. Additionally, the frequency of extreme events is or can be implemented. The inclusion of parameters depends on whether or not they are important for a particular region in a seasonal or annual manner. For this study we used the following threshold criteria :
Thermal conditions: Thermal comfort (*PET* between 22 °C and 34 °C), Heat stress (*PET* > 38 °C), Cold stress (*PET* < 18 °C),
Aesthetic and physical aspects: Cloudy (> 5 octas), Foggy (based on relative humidity > 93 %), Sultry (based on vapour pressure > 18 hPa), Rainy (precipitation > 1 mm), Long rain (precipitation > 5 mm), Windy (wind speed > 8 m/s).
The value of each factor represents the occurrence in percentages of the decades (three intervals per month).

Weather Suitability Index
The Weather Suitability Index (*WSI*) based on daily meteorological information. The bio-thermal classification of weather conditions used provides two kinds of information: about the thermophysiological state of the human organism caused by actual weather and about the occurrence of meteorological situations that can affect outdoor recreation (Blazejczyk, 2007a, 2007b). The particular weather features were defined based on the human heat balance model MENEX_2005 for every day of the studied period with the use of BioKlima©2.5 software package.
WSI provides weather information described by seven digits: thermal sensations (due to *STI*), radiation stimuli (due to absorbed portion of radiation), physiological strain (due to *PhS* index), sultriness (due to *HSI* index), daily thermal contrast (due to temperature amplitude), rain(snow) fall (> 1 mm), snow cover (> 10 cm) (Table 1). For example, the code -2_2C0_011 indicates cold weather (-2) with moderated radiation stimuli (2), cold physiological strain (C), non sultry (0) with insignificant daily thermal contrast (0), rain(snow) fall (1) and snow cover (1).
Each individual weather conditions was assessed from the point of view of particular forms of recreation: sun baths (SB), air baths (AB), mild recreational activity (e.g. walking, light plays, shopping – MR), intensive recreation and summer tourism (e.g. football, biking, climbing, jogging etc. – AR), ski tourism (ST). Every weather situation was evaluated using *WSI* as follows: 0 – unfavourable, 1 – favourable with limitations, 3 – favourable without limitations. Because of its nature *WSI* is not calculated with a mathematical formula but using a lookup table. Such a table contains the *WSI*_XX (i.e. SB, AB, MR, AR,

ST) values corresponding to every weather class (BioKlima©2.5. help file).

Table 1. The scheme of bio-thermal weather classification

	Weather component						
	Weather type	Weather subtype			Weather class		
	Thermal sensation	Radiation stimuli	Physiological strain:	Sultriness intensity	Daily thermal contrast	Precipitation	Snow cover
Site of weather indicator	1	2	3	4	5	6	7
Weather indicator	**-3** (very cold) **-2** (cold) **-1** (cool) **0** (comfortable) **1** (warm) **2** (hot) **3** (very hot)	**1** (weak) **2** (moderate) **3** (great)	**C** (cold) **T** (neutral) **H** (hot)	**0** (non sultry) **1** (moderate) **2** (great)	**0** (weak) **1** (significant)	**0** (no precipitation) **1** (precipitation >1 mm)	**0** (no snow) **1** (snow cover >10 cm)

The results obtained with the use of CTIS and *WSI* will be compared with the values of Mieczkowski's Tourism Climate Index (TCI) (Mieczkowski 1985). The weather analysis based on daily meteorological data for the period 1991-2000 from four stations (Helsinki, Paris, Cracow and Athens) represented various climatic regions of Europe. TCI was calculated based on monthly values of relevant climatic data from the period 1981-1990.

3. RESULTS

In Fig. 1 the CTIS for Helsinki, Cracow, Pairs, Athens including several facets of climate in tourism (de Freitas, 2003, Matzarakis, 2007) are shown. Several values and parameters are illustrated, for which data exist or can easily be calculated. All used parameters, except precipitation, build the input parameters for the calculation of thermal comfort indices in the CTIS as well (Matzarakis, 2007, Matzarakis and Rutz, 2005, Matzarakis et al., 2007a, b, VDI, 1998). CTIS shows great regional differentiations in weather characteristics. In Helsinki weather limitations for tourism are related to frequent occurrence of cloudy days all over the year and cold days from November till middle of March. In Cracow similar weather limitations are observed. Additionally, in June, July and August frequency of sultry days is greater than 50%. In Paris tourism activity can be limited mainly by cloud cover. In Athens weather limitations for active tourism occur from June till September. They are mainly related to great sultriness that is observed during this period.
Weather Suitability Index (*WSI*) provides another message for tourists and recreationists. It informs about usefulness of particular weather situations for different forms of activity. Fig. 2 shows various regional patterns in seasonal variability of *WSI*. In Helsinki the weather conditions most favourable for passive recreation (sun and air baths) occur in the summer months. However, intensive forms of active recreation can be practiced the whole year. On the other side, in Athens summer weather is unfavourable for active recreation. Also weather favourability for passive recreation is smaller than in spring, autumn and winter. For the stations situated in middle latitudes (Paris, Cracow) passive forms of recreations can be applied from the beginning of May till October. However, for active forms of recreation the weather is favourable all over the year, with slight limitations in the summer season.
The classical Mieczkowski's approach provides very simplified annual cycle of *TCI*. It mostly depends on seasonal variability of climatic parameters (mainly air temperature and sunshine duration) observed in middle latitudes. Only in Athens slight summer decrease in *TCI* is noted. Due to *TCI* classification *TCI* values still indicate good and very good conditions for climate.

4. CONCLUSIONS

The methods used for evaluation of climate conditions for tourism and recreation (CTIS, *WSI*) are supplementary approaches. The CTIS provide information about the frequency of various features of weather in consecutive 10-days periods of the year. The user can analyse which weather properties are useful for his favourable tourism activity. On the other hand, the *WSI* provides

synthetic information dealing with usefulness of weather for different forms of recreational and tourism activities: passive (sun and air baths) and active (mild and intensive).
In comparison to classic TCI approach, the new weather orientated methods provide physiologically relevant information for tourists and recreants with detail time resolution (10-days or even 5 day periods). CTIS and *WSI* can be the basis for reasonable planning of tourism and recreational activities for particular seasons.

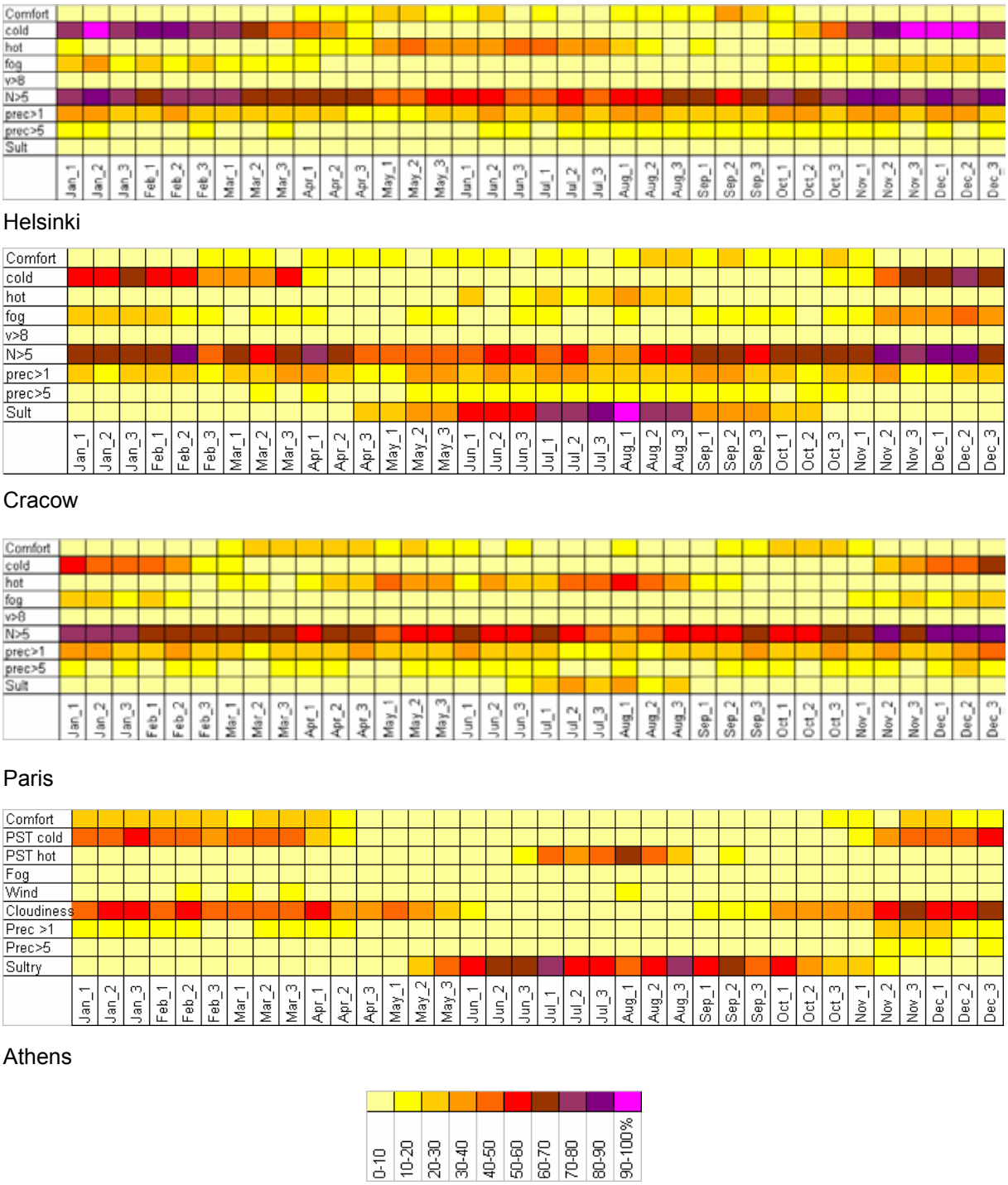

Fig. 1. Climate Tourism Information Scheme (CTIS) based on 10-days intervals for Helsinki, Cracow, Paris and Athens.

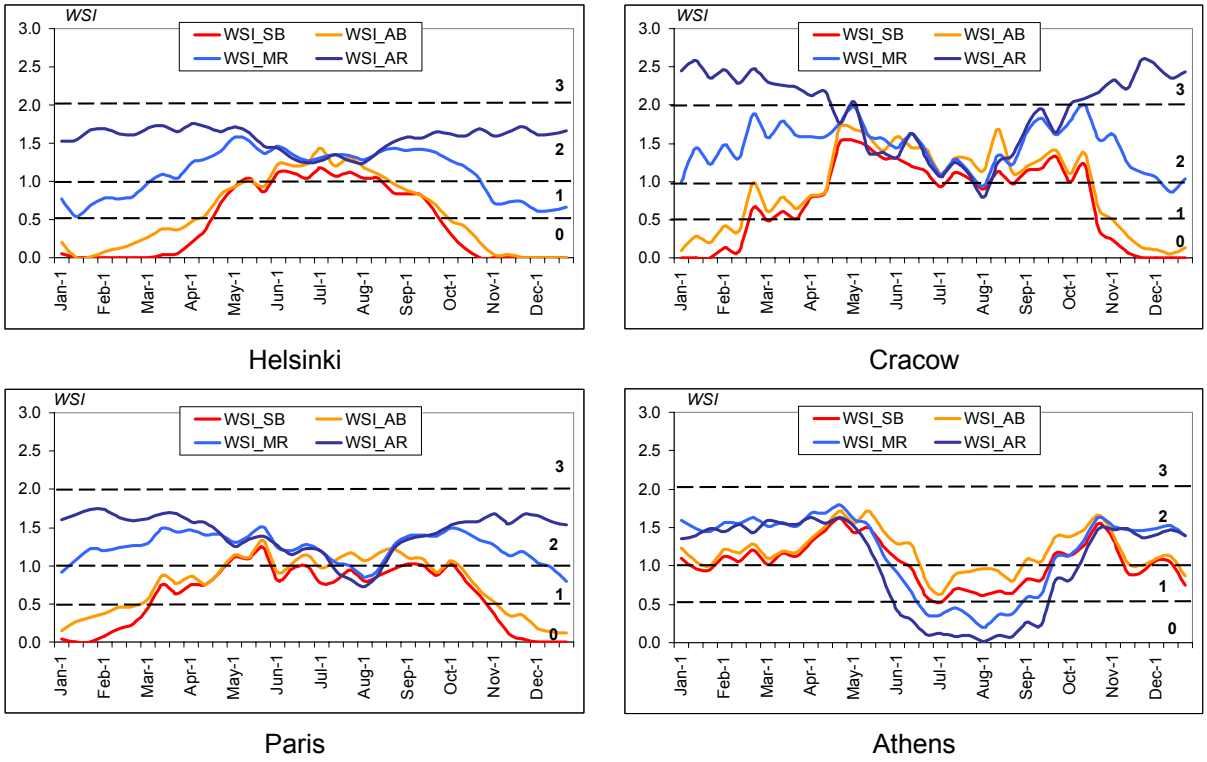

Fig. 2. Weather Suitability Indices for sun baths (WSI_SB), air baths (WSI_AB) as well as mild (WSI_MR) and intensive (WSI_AR) forms of active recreation for 10-days intervals for Helsinki, Cracow, Paris and Athens; 0 – unfavourable, 1 – moderately favourable, 2 – favourable, 3 – very favourable

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