CLIMATE AS A RISK FACTOR FOR TOURISM

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Abstract
Weather and climate risk factors for tourism are surveyed and illustrated with regard to the expected climate changes in Hungary. These changes are not at all advantageous and which affect the business in question both directly and indirectly. These are the summer resort tourism (characterised by bio-climatic indices). Green tourism is the next one to characterise, including skiing, mountain climbing and eco-tourism, as well. Here both day-to-day weather extremes and long-lasting effects on the biota (e.g. drought, or inundation for plain-area eco-tourism). Last, but not least the urban (cultural- and shopping-) tourism is presented, since the large towns exhibit their special climate and different risks. The paper intends to specify these meteorological factors and effects also in terms of the different types of touristic activities. The general statements on the effect of weather and climate on tourism are illustrated by a few individual parameters and also by the so called Physiologically Equivalent Temperature. Annual and diurnal course of this parameter are presented, together with various trends in this variable at different sites and in different (hot and cold) extremities of the occurring values. Other examples, helping the tourism industry are presented in various climate conditions of the country. They include high precipitation and high relative humidity information. The paper also lists the possible adaptation measures to extreme events and also their likely changes in time.

Keywords: Hungary, extreme weather, climate change, tourism, adaptation.

1. Introduction

Weather and climate, together with natural resources such as geographical location, orography and landscape play a vital role in tourism and recreation (de Freitas, 2003). Because outdoor recreation is very sensitive to weather, weather and climate, although amongst the most important features attracting tourists, are also limiting factors (Perry, 1972). Health tourism is even more sensitive to climate conditions, especially to thermal conditions (Didaskalou et al. 2004; Zaninović, 1998) and health tourism operators should pay particular attention to thermal conditions to avoid adverse consequences for visitors to health resorts.

Unfortunately, the role of climate in determining the suitability of a region for recreational or health tourism is often assumed to be self-evident and therefore to require no elaboration (de Freitas, 2003; de Freitas and Matzarakis, 2005). Misleading or selective climate information may give the tourist a false impression of their destination (Perry, 1993). However, climate-related information is often very poor and barely helps tourists in planning and scheduling their holidays or in the promotion of a tourist destination in publicity campaigns.

Though some recent publications provide overviews of the climate issue in relation to tourism and leisure (Hall and Higham, 2005; Gössling and Hall, 2006; Becken and Hay, 2007; Scott et al. 2008), the effects of climate change on tourist flows and recreation patterns, these views are still far from finally established. In Hungary, considerable efforts should also be mentioned, especially in respect to the water tourism (i.e. Németh and Dávid, 2007; Dávid et al. 2009). The issue is rather complex since mountain tourism, lakes, streams, forest ecosystems, coastal and marine environment, savannah regions, urban areas, biodiversity, disease and biosecurity all comprehend series of mutually interacting effects of climate variations and weather extremes. In the following Sections we also try to give an overview mainly focusing on the weather and climate extremes as risk factors for tourism.

2. Weather characteristics and tourism

2.1 Weather relatedness of the tourism business

The famous cities are attracting many tourists. For this *urban tourism* the highest risk is the heat island effect that enhances the sometimes otherways high temperatures during the day and even until late evenings. In the big cities is already of the same magnitude as the expected climate change in the next hundred years. Cities in tropics and middle latitudes are likely to become more unpleasant for tourists during the hottest months. In middle latitudes heat waves will become more intensive and more frequent. Severe heat stress can result in deterioration in health including heat illness. Direct health effects would include increases in heat-related mortality and illness resulting from an anticipated increase in heat waves, although offset to some degree in temperate regions by reductions in winter mortality.

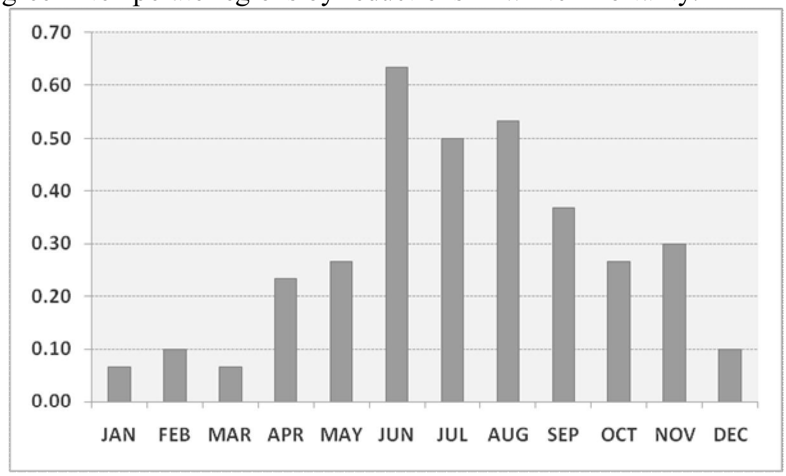


Fig. 1. Annual course in monthly number of days with precipitation ≥ 20 mm in Budapest

Selection of season for visiting the towns is also season-dependent due to the duration of the daylight and sunshine for sightseeing and taking pictures. There are also several humidity factors which exhibit parallel annual cycles, but which are not always considered by the visitors (or considered erroneously, based on their home-based climate experience). Figures 1 and 2 present such variables for capital cities of Hungary. The first one is the probability of precipitation ≥ 20 mm in 24 hours and the second one is the average number of days with relative humidity ≥ 80% at 12 UTC in Budapest.

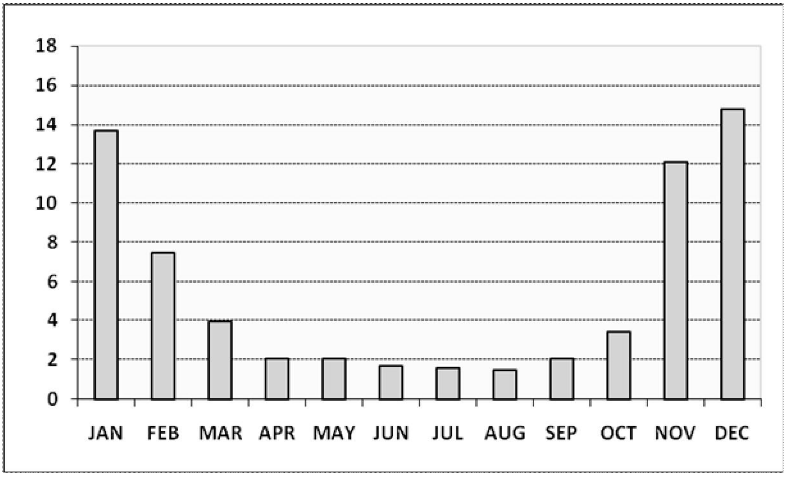


Fig. 2. Annual course in number of days with relative humidity ≥ 80% at 12 UTC in Budapest

Rural tourism, particularly in the mountainous areas, has traditionally been popular among free-time spenders all over the world. In summer for hiking and other recreation activities, including spas, and in winter largely based on typical winter sports. Since many locations lie on lower altitudes, their vulnerability to warmer winter and less snow cover is considerably higher (Agrawala, 2007).

Mountain environment is very sensitive to weather. For many alpine areas winter tourism is the most important income source, snow-reliability is one of the essential elements of touristic offer. As the temperature increases in the mountains, this also causes problems to ski slopes on glaciers in winter and summer skiing. Rising temperatures also cause melting of permafrost, consequently mountain areas are vulnerable to landslides, infrastructure becomes instable and hiking and climbing are more dangerous due to increasing rockfall, putting under risk even the summer activities in mountain area (hiking, trekking, biking).

Islands, coasts and beaches are the pleasant sites for *beach tourism*. Different impacts on this environment tend to be the most threatening. The rise in sea level will cause coast and beach erosion, inundation of flood plains, destruction of coastal ecosystems, water-table rising, aquifer salinisation and submersion coastal plains. Since the coastal zones have often fertile soils, and are in favour for housing near the sea (ports, fisheries), the pressure on the yet undisturbed coastal zone is great.

There are many coastal activities laying their own claims to the coastal zone. Main activities are transport, aquaculture fishery, agriculture, forestry, human settlement, mining, recreation and tourism. Some major problems encountered in coastal development are the deterioration of coastal resources by destruction, over-exploitation and un-economical use; development activities along the coast, which create adverse affects on coastal resources; upland development activities having negative impact upon the downstream coastal areas and, finally, sea level rise and land fall resulting in inundation of coastal lowlands.

Health tourism is the sum of all the relationships and phenomena resulting from a change of location and residence by people in order to promote, stabilize and restore their physical or mental well-being, using health services (Kaspar, 1996). One can divide it into two forms: medical tourism and wellness tourism. The hearts of the medical tourism are the healing and rehabilitation. The therapy is the most important among the medical and tourist services which based on natural medicinal factors (thermal water, cave, medical mud, and microclimate), and the general tourist services complement it only. The subalpine bioclimate, for example, plays an important part inhealing and prevention of different respiratory and thyroid disease, cardiac and circulatory disease, anaemia or exhaustion at our climatic health resorts (Németh, 2008). Weather and climate have a considerable influence on asthma, hay fever and other respiratory disorders caused by various allergens, pollens and pollutants, so spending a holiday in places with healthy climate could result in enhanced work efficiency and help to prevent illnesses.

Finally let us briefly specify some *sport activities*, from the risk point of view, that are parts of various touristic activities tackled above. Need for meteorological data of some of them goes beyond information provided on regular basis in the frame of weather forecasts. Extreme sports require even better meteorological support. Some tourists may expose themselves to risk (surfing, waterskiing, winter sports, hanggliding, etc.) which make them particularly vulnerable. No tourist season is complete without the sad news of accidents befalling tourists engaged in some particular form of sporting or mountaineering activity and who are surprised by a sudden onset disaster or simply an adverse change in weather conditions. Let us list the weather effects on sporting individuals through one frequent way of free-time sport.

This is the *distance running* in which the individuals are mostly subject to the ambient environment. In case of bad weather conditions as high temperature, low atmospheric pressure, high humidity or strong wind, heavy rain, etc., many runners would even find it difficult to perform the planned number of kilometres. The higher the temperature is, the more physical strength will be consumed. In a hot environment, the energy supply of the human's anaerobic metabolism will increase relatively. In addition, sunshine is also an important factor, since the sunlight will increase the athletes' body temperature, and more importantly the solar infrared radiation will reduce one's capacity to dissipate body heat. Cloud amount reflects how much the sunlight, so cloudy day is most favourable for long distance running. The impact of precipitation on it is the two sides of a coin. On one hand, heavy rain will affect the performance. On the other hand, a slight rain is most advantageous for keeping the runner fresh. Although the athletes will feel uncomfortable if their clothes get wet, the rainwater on body surface will lead to faster sweat evaporation and body heat dissipation, which is favourable for performing longer distance or doing it in shorter time period.

All above weather elements, affecting the tourism, are primarily correlated with series of circulation patterns often coded into finite number of possible types, the so called macro-synoptic types (Péczely, 1957) or front-types (Puskás, 2001). Some of these circulation types have long series of diurnal codes with analyses their long-term fluctuations (Makra, 1980). There are also impact studies linking circulation fluctuations to anomalies of the living environment (e.g. Nowinszky and Puskás, 2003). Some other papers, however, indicate that the effect of circulation on diurnal weather is rather complicated (Mika et al. 2005).

Moreover, Károssy et al. (2002, 2004) even provided some touristic argiments in connection with the Péczely-types, menmtioned in the above paragraph. For example, long series of anticyclonic types indicate sunny weather. Or, hidden cold fronts cause danger, and, hence frequent task for the Balaton Storm Warning Observatory, in connection with one of the 13 macrosynoptic types of the country.

2.2 Weather extremes

Extreme weather event is an event that is rare within its statistical reference distribution at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called "extreme weather" may vary from place to place. An "extreme climate event" is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season). The longer-term, precipitation- and temperature-driven set of extremities contain drought, wildland fires, heat-waves, temperature extremes, melting of permafrost and occurrence of snow avalanches, etc.

Specific concern in tourism at the middle latitudes are caused by thunderstorms, tornadoes, hail, dust storms and smoke, fog and fire weather. These small-scale severe weather phenomena, that are sparse in space and time, may have important impacts on societies, such as loss of life and property damage. Their temporal scales range from minutes to a few days at any location and typically cover spatial scales from hundreds of meters to hundreds of kilometers. These extremes are accompanied with further hydrometeorological hazards, like floods, debris and mudslides, storm surges, wind, rain and other severe storms, blizzards, lightning. For example, mudslides disrupt electric, water, sewer and gas lines. They wash out roads and create health problems when sewage or flood water spills down hillsides, often contaminating drinking water. Power lines and fallen tree limbs can be dangerous and can cause electric shock. Alternate heat sources used improperly can lead to death or illness from fire or carbon monoxide poisoning.

Extreme events are often the consequence of a combination of factors that may not individually be extreme in and of themselves. Complex extreme events are often preconditioned by a pre-existing, non-extreme condition, such as the flooding that may result when there is precipitation on frozen ground. In addition, non-climatic factors often play a role in complex extreme events, such as air quality extremes that result from a combination of high temperatures, high emissions of smog precursors, and a stagnant circulation. Very often there is a possibility to predict quite accurately the probability of severe weather events and issue warnings, or even close the endangered region temporarily. But, tourists often do not speak the language of the country in which they are spending vacation. They do not know the local signs of danger and some of them do not respect warnings and prohibitions to enter the endangered areas.

3. Climate change and tourism

IPCC WG-I (2007), the FAQ. 3.3 states: "Since 1950, the number of heat waves has increased and widespread increases have occurred in the numbers of warm nights. The extent of regions affected by droughts has also increased as precipitation over land has marginally decreased while evaporation has increased due to warmer conditions. Generally, numbers of heavy daily precipitation events that lead to flooding have increased, but not everywhere. In the extra-tropics, variations in tracks and intensity of storms reflect variations in major features of the atmospheric circulation, such as the North Atlantic Oscillation."

In more details one can further read the following "inconvenient" statements related to the Central European region in the appropriate pages of IPCC WG-II (2007): *Central and eastern Europe:* more temperature extremes, less summer precipitation, more river floods in winter, higher water temperature, higher crop yield variability, increased forest fire danger. *Mountain areas:* high temperature increase, less glacier mass, less mountain permafrost, upwards shift of plants and animals, less ski tourism in winter, higher soil erosion risk, high risk of species extinction. *Mediterranean region:* decrease in annual precipitation, decrease in annual river flow, more forest fires, lower crop yields, increasing water demand for agriculture, less energy by hydropower, more fatalities by heat waves, more vector-borne diseases, less summer tourism, higher risk of biodiversity loss.

None of these changes are advantageous, but all of them are somehow related to tourism, since climate is a principal resource for tourism. It co-determines the suitability of locations for a wide range of tourist activities, is a principal driver of global seasonality in tourism demand, and has an important influence on operating costs, such as heating-cooling, snowmaking, irrigation, food and water supply, and insurance costs (Simpson et al. 2008). Studies indicate that a shift of attractive climatic conditions for tourism towards higher latitudes and altitudes is very likely. Uncertainties related to tourist climate preference and destination loyalty require attention if the implications for the geographic and seasonal redistribution of visitor flows are to be projected (UNWTO-UNEP-WMO 2008).

During the last few years, many parts of the world have suffered major heat waves, floods, droughts, soil moisture deficits, fires and extreme weather events leading to significant economic losses and even loss of life. Climate change could further exacerbate the frequency and magnitude of droughts in some places. Indirect effects of the global warming would include extensions of the range and season for vector organisms (e.g., mosquito, etc.), often increasing the likelihood of transmission of vector-borne infectious diseases (e.g., encephalitis). Some increases in non-vector-borne infectious diseases such as salmonellosis and other food- and water-related infections could also occur, because of climatic impacts on water distribution and temperature, and on micro-organism proliferation.

Sea-level rise is projected to have negative impacts on human settlements, tourism, freshwater supplies, fisheries, exposed infrastructure, agricultural lands and wetlands, causing loss of land, economic losses. Changes in water availability, biodiversity loss, reduced landscape aesthetic, altered agricultural production (e.g., food and wine tourism), increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases will all impact tourism to varying degrees (UNWTO-UNEP-WMO 2008).

It can be expected that climate change will have some effect on desire and necessity of people to travel to places with different climate; mobility, this concerning available transport means, transport safety and convenience; safety; weather extremes are expected to become more frequent and intense; appeal of tourist destinations; some new destinations may appear, and some traditional destinations may lose their present appeal, or could even disappear; frequency of particular weather conditions suitable for different sports at selected tourist destinations.

Finally let us mention a group of people who are not tourists, per se, but who are also affected by climate and weather. They are the people who can afford to leave home for several weeks or months tend to escape the stress of hot summers or cold winters at their permanent residence. Winter in polluted cities is unpleasant and unhealthy; hot summer weather with high ozone levels in dense urbanized areas is as well unpleasant and unhealthy. As the number of people being able to temporarily move to milder and healthier climate is constantly increasing, the number of seasonal migrants is expected to grow in the future.

4. Bioclimatic indices to characterise the thermal environment

The thermal comfort index is calculated by means of the physiologically equivalent temperature PET as the physiologically significant assessment of the thermal environment based at the human energy balance (Matzarakis and Mayer, 1997; Höppe, 1999; Matzarakis et al. 1999). For calculating PET the RayMan model can be used, using four meteorological parameters (air temperature, relative humidity, wind speed and cloudiness) as well as some assumed physiological parameters (age, genus, bodyweight and height, average clothing and working). According to the experience, an average weighted and dressed male person feels optimal in the 18-23°C PET range. At the same time, any value above 35°C is already reported as unpleasantly too hot.

In Figure 3 we demonstrate the average annual and diurnal course of this variable in Budapest. In order to identify the changes during the day, the index for observed climate has been calculated for observation terms 7 a.m., 2 p.m. and 9 p.m. local time. (Coordinates of Budapest and the three other stations used below are collected in Table 1.) These climate normal-based diagrams do not properly indicate the danger of temperature extremes especially in the summer period. Hence, we also demonstrate the probability of PET>35°C (Figure 4). This value is already significant from health point of view in case of touristic leisure. Besides that, in Table 2 one can also find the probabilities of overshooting the even more dangerous threshold PET>41°C. For convenience, these numbers are expressed in the unit of occurrence per month.

Table 1. Horizontal and vertical coordinates of stations for Figs 4-5.

Station	*Latitude (deg. N)*	*Longitude (deg E)*	*Altitude (m a. s. l.)*
Kékestető	47°52’	20°01’	1011
Budapest	47°26’	19°11’	138
Siófok	46°55’	18°02’	112
Szeged	46°15’	20°07’	79

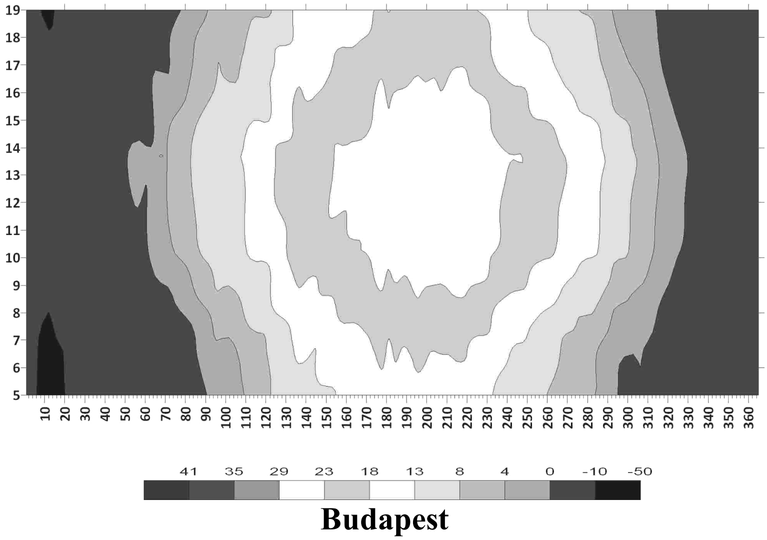


Fig. 3. Average annual and diurnal cycle of PET in Budapest (1961-1990).

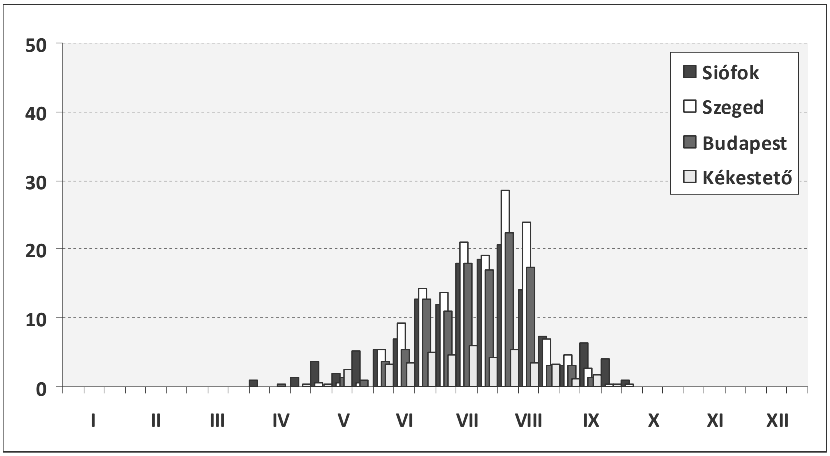
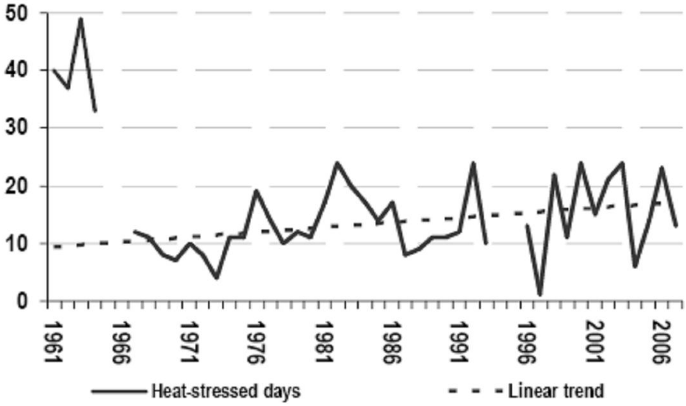


Fig. 4. Probability of occurrence of PET >35°C in ten-day periods during the year at 2 PM. The figures clearly indicate the marked spatial difference and the intra-seasonal differences.

Table 2. Average number of days overshooting the PET>41 ^oC in the affected months at the four selected sites at 2 pm in Hungary.

PET >41^{o}C	Kékestető	Budapest	Siófok	Szeged
MAY	0,0	0,0	0,5	0,0
JUNE	0,1	0,4	2,1	0,8
JULY	0,3	0,4	4,4	1,7
AUG.	0,1	0,7	2,7	2,3
SEP.	0,0	0,0	0,7	0,1

The same PET index can also be used to detect climate changes in a given site. For demonstration of this possibility, the PET values were computed from the 12 UTC data series (for selected hours) of the Kékestető synoptic station. In its previous position before 1966 the station was just about 990 m above the see-level, hence the trends are computed after this time, only. According the data series the number of heat-stressed days (when the PET > 29°C) increased whilst the number of cold-stressed days (PET < 0°C) decreased in the examined period (Fig.5.).



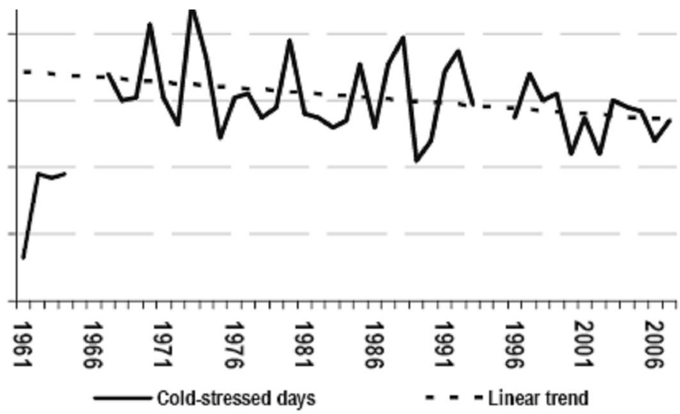


Fig. 5. Variation of number of heat-stressed days (left) and cold-stressed days (right)
(the linear trend calculated for 1967-2007)

Another comparison can be seen in Fig. 6. The sumer mean PET values exhibit definitely stronger changes in the capital city (Budapest Pestszentlőrinc, in the sub-urban zone) than at the south-eastern beach of the Lake Balaton (Siófok, near the lake) The decadal increase of this heat-balance indicator was almost 1 °C/10 years in Budapest during the 46 years, whereas the same thrend was just ca. the half of this value near the Lake Balaton. The differcne might be explained by changes in both the temperature (damping effect of the Lake) and also in the cloudiness and humidity factors of the PET.

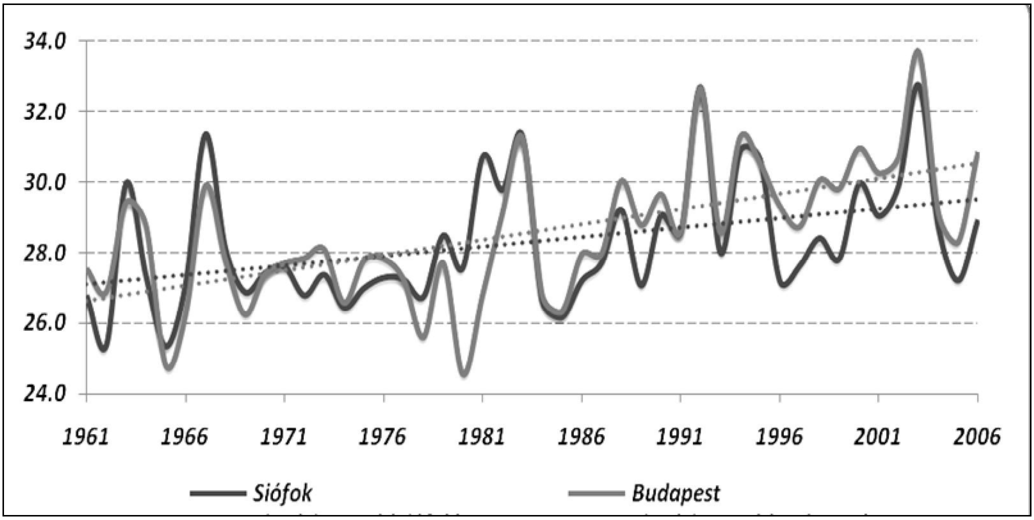


Fig. 6. Summer mean PET values with their differing linear trends in 1961–2006. The changes are stronger in Budapest (outskirts) than is Siófok, near the Lake Balaton

5. Adaptation to the weather and climate extremes

The application of disaster preparedness to tourism will involve a number of measures. Tour operators and the tourists should be involved in the process of dissemination of warnings, in the response to the warnings and any evacuation process.

Adaptation strategies include technical measures, sometimes with preliminary research efforts, such as snowmaking, slope contouring, rainwater collection and water recycling, reservoirs, water conservation plans, desalination plants at the shores, or introduction of new site locations (e.g. north facing slopes, higher elevations for ski areas, high snow fall areas). Another group of measures is the adapting regulations, such as fee structures for water consumption, compulsory prediction in case of risk of avalanche or enhanced UV radiation, advanced building design and prescription of given (e.g. fire-resistant) material standards for insurance, convention- or event insurance for the case of danger, insurance premiums or, simply, restriction of high-risk business operations, etc.

Development of an early warning system should be specific to the vulnerable groups. Tourists can be particularly vulnerable, because in case of a general warning in a region, they are unlikely to know what specific actions to take and may be difficult to inform because of the language barriers.

6. Discussion

Though climate and its changes affect all touristic activities, one can not consider the connection between touristic demand and climate to be well researched. Hence one can answer a series of questions just in the future. For example: How would the climate change re.arrange the sequence of the favourite touristic destinations? How will these changes interfere with such non-climate factors as terrorism, the epidemies and the natural catastrophes. How can the changes fuel prices affect the selection of destination.

One can be sure in two things, only. Firstly, in case if mankind can develop without global tragedies, the share of tourism in the world economy remains significant in the future. On the other hand, the global warming will most likely continue in the next decades, at least. Consequently, we would better make use of the warmer climate in our country and the too hot climate in the Mediterranean region. But, besides the economical development, this would also need conservation of natural values and the hot springs, keeping clean the forests and the beaches, and adequate measures to avoid dramatic wildfires. Keeping the touristic potential of these natural values competitive is one more reason to pay special attention to these objects.

References

Agrawala, S (ed) (2007): Climate Change in the European Alps. Adapting winter tourism and natural hazards management. OECD Publishing – ISBN 92-64-03168-5

Becken, S. – Hay, J. (2007): Tourism and Climate Change – risks and opportunities. Clevedon: Channel View Publications.

de Freitas, C.R. (1990): Recreation climate assessment. *International Journal of Climatology* **10**: 89-103

de Freitas, C.R. (2003) Tourism climatology: evaluating environmental information for decision making and business planning in the recreation and tourism sector. *Int. J. Biometeorol.* **48**: 45–54

de Freitas, C.R. – Matzarakis, A. (2005): Recent developments in tourism climatology. *Bulletin of the German Meteorological Society* 1/2005: 2–4

Dávid, L. – Baros, Z. – Patkós, Cs. (2009): New Concepts and Results in Analysing the Relations between Lake Tourism and Global Climate Change. In: Travel and Tourism int he Age of Climate Change: Robust Findings, Key Uncertainties, CD-ROM and Book of Abstracts, pp. 22-23.

Didaskalou, E.A. – Nastos, P. – Matzarakis, A. (2004): The development prospects of Greek health tourism and the role of the bioclimatic conditions of Greece. *Ber. Meteor. Inst. Univ. Freiburg* **12**: 149–157

Gössling, S. – Hall, C.M. (eds.) (2006): Tourism and Global Environmental Change. Ecological, Social, Economic and Political Interrelationships. London. Routledge.

Hall, C.M. – Higham, J. (eds) (2005): Tourism, Recreation and Climate Change. Clevedon: Channel View Publications

Höppe, P (1999): The physiological equivalent temperature – a universal index for the biometeorological assessment of the thermal environment. *Int. J. Biometeorol.* **43**: 71–75

IPCC, WG-I (2007): Climate Change 2007: The Physical Science Basis. Contribution of WG-I to the Fourth Assessment Report of the IPCC, Cambridge Univ. Press, 996 pp.

IPCC, WG-II (2007): Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of WG-II to the Fourth Assessm. Report of the IPCC, Cambridge Univ. Press.

Károssy, Cs. – Mihály, I. – Puskás, J. (2004): The representative weather characteristics in Hungary in a point of view of visitor service. 2nd International Workshop on Climate, Tourism and Recreation, Kolimbari, Greece 8-11 June p. 6-7.

Károssy, Cs. – Puskás, J. – Nagy É. (2002): Macrosynoptical sphereinformation database of the lower tropospherical atmosphere in Carpathian Basin. Some data on statistical features of the Péczely's weather situations of Central-Europe. Proceedings of 6th Hellenic Conference in Meteorology Climatology and Atmospheric Physics, Ioannina, 25-28 September, pp. 630-633.

Kaspar, C. (1996): Gesundheitstourismus im Trend. In: Institut für Tourismus und Verkehrswirtschaft.Jahrb. Schweizer Tourismuswirtschaft. 1995/96, St. Gallen p. 53-61.

Makra, L. 1980: Large Scale Weather Situations in Hungary and the Periodical Components of their Time Array. *Acta Climatologica Universitatis Szegediensis* **16-17** (1-4): 19-43.

Matzarakis, A. ─ Mayer H. (1997): Heat stress in Greece, *Int. J. Biometeorol.* **41**: 34-39.

Matzarakis, A. ─ Mayer, H. ─ Iziomon, M.G. (1999): Applications of a universal thermal index: physiological equivalent temperature. *Int. J. Biometeorology* 43: 76-84.

Mika J. ─ Molnár, J. ─ Tar, K., 2005: Effects of macro-circulation on local climatic conditions of plant development. *Physics and Chemistry of the Earth* vol. 30, 135-141

Németh, Á. 2008: Bioclimatology. In: Holicska, Sz. [ed.]: Weather that stresses people. Medical meteorology for everyone. Athenaeum 2000. pp. 180-200. (in Hungarian).

Németh, Á. – Dávid, L. (eds.) (2007): Handbook of Lakes and Reservoirs – a Sustainable Vision of Tourism Handbooks of Water-based Tourism, Volume 1, Department of Tourism and Regional Development, Károly Róbert College, Gyöngyös, 146.p.

Nowinszky, L. – Puskás J. (2003): Light-trap effectiveness depending on the Péczely's and Hess-Brezowsky's macrosynoptic weather situations. In: 3rd International Plant Protection Symposium, Debrecen (October 15-16) pp. 237-245.

Péczely, Gy. (1957): Macrosynoptic types in Hungary. (Grosswetterlagen in Ungarn.) Kleinere Veröff. der Zentralanstalt für Meteorologie, No. 30, Budapest

Perry, A.H. (1972): Weather, climate and tourism. *Weather* 27:199–203

Perry, A.H. (1993): Climate and weather information for the package holiday-maker. *Weather* 48: 410–414

Puskás, J. 2001: New weather front types and catalogue for the Carpathian Basin. In: Nowinszky L. ed.: Light trapping of insects influenced by abiotic factors Part III. Savaria University Press Szombathely 87-118.

Scott, D. – Amelung, B. – Becken, S. – Ceron, J.P. – Dubois, G. – Gossling, S. – Peeters, P. – Simpson, M. (2008): Climate Change and Tourism: Responding to Global Challenges. World Tourism Organization, Madrid – United Nations Environment Programme, Paris.

Simpson, M.C. – Gössling, S. – Scott, D. – Hall, C.M. – Gladin, E. (2008): Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices. UNEP, University of Oxford, UNWTO, WMO: Paris, France, pp. 136

UNWTO – UNEP – WMO (2008), Climate Change and Tourism: Responding to Global Challenges, (prep. by Scott, D., Amelung, B., Becken, S., Ceron, J.P., Dubois, G., Gössling, S., Peeters, P. and Simpson, M.C.) UNWTO, Madrid – UNEP, Paris.

Zaninović, K (1998): Bioclimatic preferences of Hvar for the development of health tourism (in Croatian). In: Health and tourism. Split/Hvar, pp 63–67