ADJUSTMENT OF TOURISM CLIMATOLOGICAL INDICATORS FOR THE HUNGARIAN POPULATION IN ASSESSING EXPOSURE AND VULNERABILITY TO CLIMATE CHANGE

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Introduction

The demand for tourism is sensitive to climate variability and climate change, and impacts will vary geographically and seasonally. Sea level rise, ocean acidification, and extreme weather events have negative effects on the touristic potential and infrastructure of coastal and urbanized regions. Temperature increase in wintertime reduces the operation period of ski centers, while summer warming negatively influences the health and thermal comfort of tourists. In particular, urban centers that are major tourism destinations may suffer when the weather becomes excessively hot, and this may lead to a loss of revenue (IPCC, 2014).

When considering Europe, climate change is very likely to increase the frequency and intensity of heat waves, particularly in Southern Europe, which is highly vulnerable to climate change. The most adverse implications will occur in the tourism sector, as well as in the infrastructure, energy, and agriculture sectors (Kovats et al., 2014).

By identifying the quantitative impacts of climatic conditions and climate change on tourism, the development of objective strategy building, the decision-making process, and adaptation strategies related to the impact assessment of climate change can be facilitated. Several tourism climatological indicators and evaluation tools have been developed for this purpose; however, there have not been harmonized approaches for studying climate and climate change impacts on the tourism sector yet. To prepare targeted and sustainable adaptation strategies in response to climate change, it is indispensable to expand an objective approach helping quantify the exposure, sensitivity, and adaptive capacity of the tourism sector. Moreover, this should be differentiated on the basis of the vulnerability of the various stakeholders and areas.

National Adaptation Geo-Information System (NAGiS)

In the course of 2015, several tourism climatological indicators will be established in the dataset of the National Adaptation Geo-Information System (NAGiS) in Hungary (National Adaptation Geo-Information System, 2015). This database aims at supporting strategic planning and decision-making on the adaptation to climate change through development and operation of a multipurpose, geo-information database, which merges several data sources. The establishment of the database focused initially on the evaluation of the negative effects of climate change regarding hidrology, natural ecosystems, and agriculture (National Adaptation Geo-Information System, 2015). In the framework of the new initiative of the program entitled "Adaptation to climate change in Hungary," NAGiS will be extended to include indicators of exposure, sensitivity, and adaptive capacities in the tourism sector, as well as in critical infrastructure sectors. The new program initiative (Vulnerability and impact studies with a focus on tourism and critical infrastructures; CRIGiS) is based on the study of excess human mortality related to heatwaves and the impact and vulnerability assessment of road accidents within extreme weather events. The tourism-related sector of the project will focus on the investigation of climatic conditions on tourism based on three indicators: the well-known and relatively simple Tourism Climatic Index (TCI; Mieczkowski, 1985), the recent Climate Index for Tourism (CIT; de Freitas et al., 2008), and an adjusted form of the TCI (Kovács et al., 2015) that will be detailed in the subsequent section.

These indicators will be used to assess the exposure due to climate change. The evaluation tools will be quantified, on the one hand, based on past and present observational data, and on the other hand, based on projected regional climate model outputs (for the periods of 2021–2050 and 2071–2100). The ALADIN-Climate model used at the Hungarian Meteorological Service (HMS) will be applied for this purpose as this provides the required meteorological data in temporal detail. The climate indicators will be calculated for the area of Hungary on a 10 km horizontal resolution grid of the climate model (Fig. 1). The results will then be aggregated for sub-regions with a statistical method as this provides more beneficial results for the users, such as tourists and tourism professionals.

The vulnerability to climate change will also be determined by comparing the tourism climatic indicators with some tourism economic measures, such as hotel occupancy rate, visitors in spas or in events. These results will refer to some popular Hungarian tourist destinations or regions.

Adjustment of tourism climatic indicators used in NAGiS

It is widely accepted that tourism climate evaluation tools should be adjusted to the tourists' perceptions and preferences, or to the local climatic conditions to which the population has become accustomed. This has been emphasized by a number of studies (e.g. de Freitas, 2003; Scott et al., 2004, 2008; de Freitas et al., 2008), yet few studies have focused on this subject. Lin and Matzarakis (2008) rescaled the thermal thresholds used in the Climate-Tourism/Transfer-Information Scheme (CTIS; Matzarakis, 2007). Bafaluy et al. (2013) adapted the CIT to specifically evaluate some outdoor recreational activities, such as cycling, cultural tourism, football, or sailing. Nevertheless, these were expert-based and subjectively assessed and, thus, have not yet been empirically tested (Bafaluy et al., 2013).

Figure 1: The area of ALADIN-Climate model involved in the study (Szépszó, 2015)

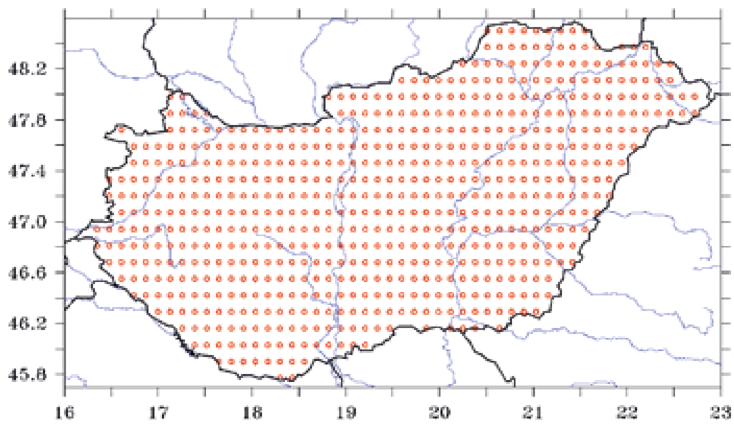
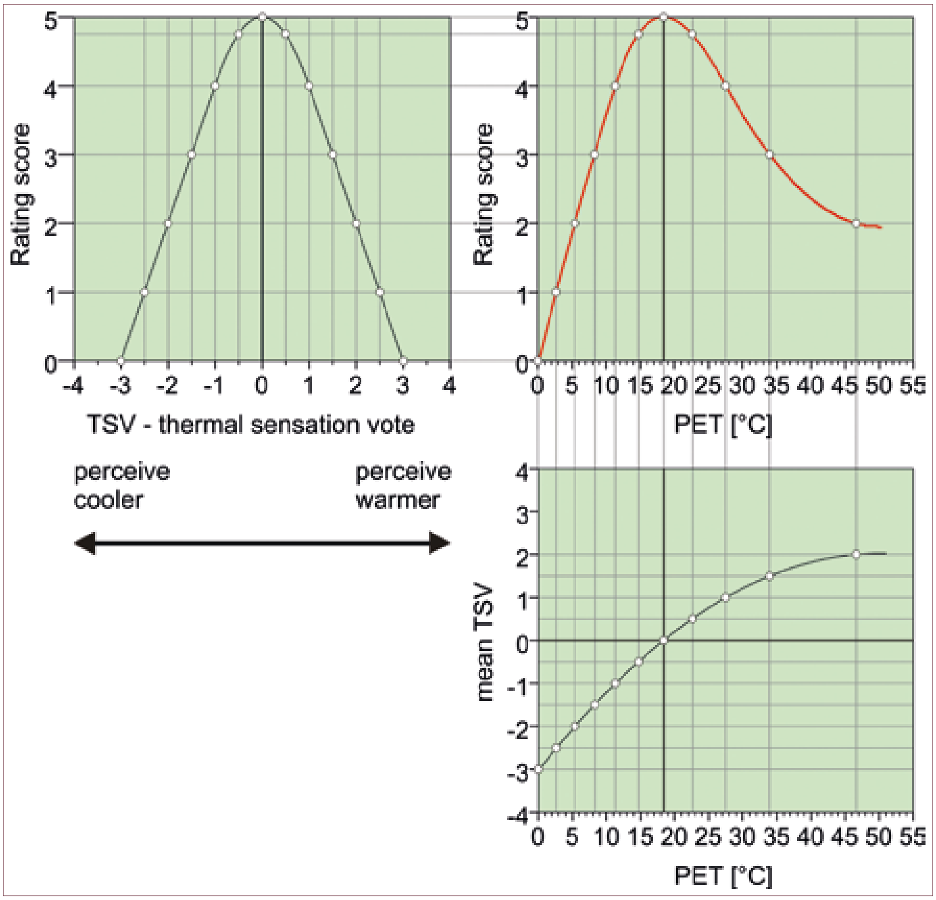


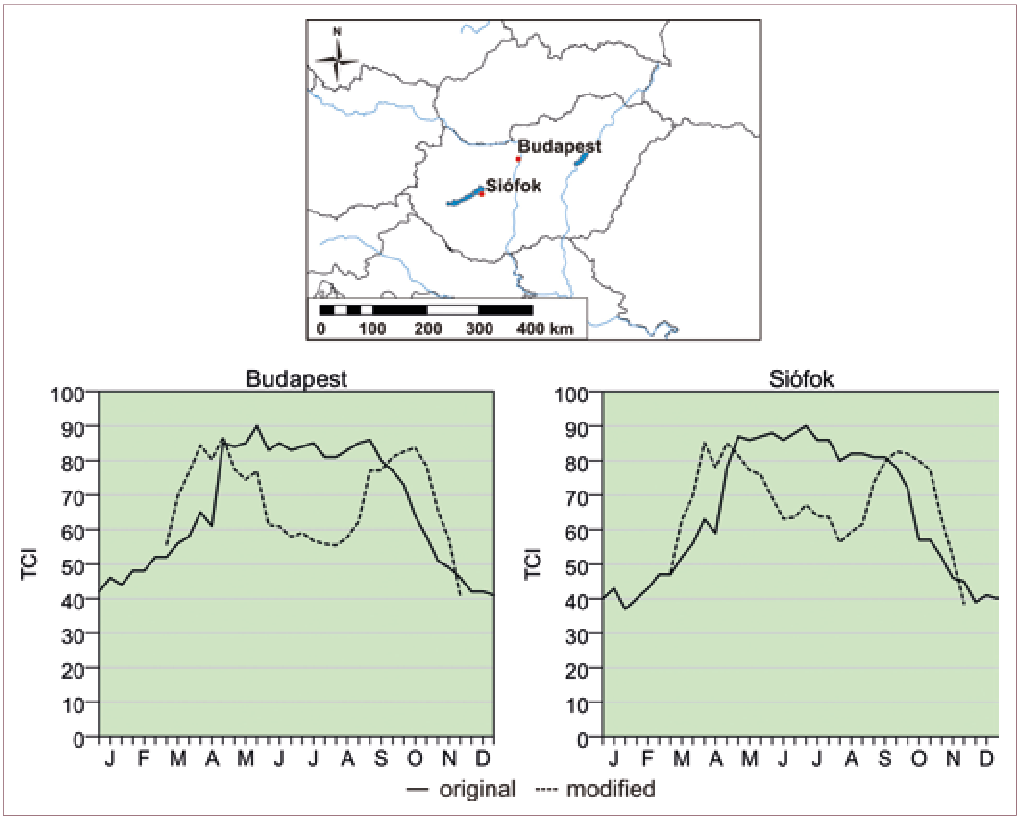
Figure 2: The process of assigning rating scores to PET necessary to the TCI (upper right chart) with the use of Thermal Sensation Vote (TSV) vs. rating score (upper left chart) and PET vs. mean TSV regression relationships (bottom right chart). The latter can be derived through a thermal comfort survey with local population (Hungarians in this case), which involves on-site micrometeorological measurements and simultaneous questionnaire surveys (Kovács et al., 2015).



Adaptation of the available evaluation tools has recently begun among the Hungarian population (Kovács and Unger, 2014a, 2014b; Kovács et al., 2015). This process focuses on the adjustment of the thermal parts of TCI and the regionalization of the thermal components of CTIS as such in order to express the subjective thermal assessment of the Hungarian population. We proposed a methodology for the integration of new, seasonal, perception-based Physiologically Equivalent Temperature (PET) rating systems into the thermal comfort sub-indices (daytime and daily comfort sub-index) of the original TCI (Kovács et al., 2015). This modification improves the potential of TCI to evaluate the thermal aspects of climate. This was performed by incorporating the widely used PET while considering the seasonal thermal assessment patterns of Hungarian residents (Fig. 2). The modified daytime and daily comfort sub-indices were derived utilizing the calculated daily maximum and daily average PET values. Furthermore, new seasonal perception-based PET category thresholds were derived and applied in the CTIS to become consistent with the subjective thermal evaluation of Hungarians (Kovács et al., 2015).

An effective way to reveal subjective thermal assessment patterns is through questionnaire surveys and simultaneous meteorological measurements in the open air and then through the pairing of the data. In our analysis, we utilized data from a 3-year-long outdoor thermal comfort campaign, conducted on 78 days in 2011, 2012 and 2015 in Szeged. The interviews and the meteorological measurements were carried out during spring, summer, and autumn in six public spaces. We recorded the thermal perception of people on a thermal sensation vote (TSV) scale and paired with the recorded weather data. The applied TSV scale ranged from −4 to 4, corresponding to the perception of very cold to very hot conditions. The data collected contained 6764 datasets of completed questionnaires and corresponding meteorological measurements.

Figure 3: Geographical location of the studied tourist destinations and the annual courses of the original and modified TCI for the period of 1996–2010



Adjusted TCI – Preliminary Results

In order to demonstrate the utility of the modified TCI, we show now some preliminary results concerning two popular Hungarian tourist destination areas. One of the tourist destinations is Budapest, the capital, the largest city of Hungary and the most popular tourist destination of the country. The other is Siófok, situated on the southern shore of Lake Balaton and is one of the most popular beach resorts in Hungary (Fig. 3). Meteorological data for the period of 1996–2010 were obtained from the measured data of the HMS for the selected locations. Fig. 3 presents the annual variations of the modified TCI for the two locations based on the derived rating scores. Also, the annual courses of the original TCI are illustrated. As shown, a summer peak was obtained in case of the original TCI at all locations, however, a bimodal distribution of TCI was found in case of the modified TCI. Namely, the most pleasant conditions occur in summer and in late spring (with TCI>80) in case of the original TCI, while this occurs in spring and early autumn (with TCI>70 or 80) in case of the modified TCI. In this case, the conditions are less favorable in summer when the TCI remains around 60 in both cities, signaling only 'good' conditions according to the evaluation scale of TCI (Fig. 3).

Conclusion

Because of the high-quality information provided by NAGiS, it is possible that further users (researchers, decision-makers) can apply the information based on the same (i.e. consistent) input data. The methodology to be prepared in the framework of the project can also be adapted to other studies as well. Outcomes of the objective impact studies point to specific actions to be taken in order to mitigate or exploit climate change impacts. The developed and included tourism-related indicators in the CRIGiS project provide significant support for touristic related services, and they will foster the development of adaptation strategies and objective decision-making to prevent climate change. Finally, we emphasized that it is important to consider the differences that exist between the subjective assessment patterns of individuals when evaluating climate resources for tourism and also climate change issues. Therefore the adjustment of the climatic indicators to the local climatic conditions is also of key importance.

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