UTCI—10 years of applications

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Foreword

In 2019, 10 years had passed when the creation of the Universal Thermal Climate Index (UTCI) was completed. Work on UTCI development had been carried out since 1999 when the ISB Commission had been set up by the Biometeorological Congress in Sydney. The task of commission was to create a new, universal indicator that could be used in a wide range of bioclimatic and biometeorological applications, irrespective of the climate zone. The indicator was also intended to fully reflect the real heat exchange processes inside the human body when it is in contact with ambient conditions. From 2006, parallel work had been carried out under Action 730 of the COST programme, with the participation of scientists from 18 European countries as well as from Israel, Canada, New Zealand and Australia.

After 2009, the index was presented to the scientific community at a number of conferences and in two dedicated publications: *International Journal of Biometeorology* (vol. 56, 2012) and *Geographia Polonica* (vol. 86, 1, 2013).

The present issue of *IJB* follows the UTCI international conference entitled “UTCI—Assessment Measure in Human Bioclimatology – 10 Years of Application”, which was held in Warsaw in May 2019. Selected conference papers were published in *Miscellanea Geographica* (2020, vol. 24, 3) and in *Geographia Polonica* (2021, vol. 94, 2).

Over the 10 years, the UTCI was applied widely in research not only in the field of bioclimatology, but also in many related scientific disciplines. The most important of the UTCI applications include assessment of regional and local features of bioclimate; urban bioclimate; recreation, tourism and sport; epidemiology and health research; biometeorological forecasts; climate change; occupational health and bioclimatic mapping. Many of them were published in

IJB. Some of above applications are represented in current special issue of the *International Journal of Biometeorology* which consists of 8 selected papers from different areas of bioclimatic research.

Vinogradova has applied UTCI to assess the bioclimate over the territory of Russia. Seasonal and region-specific features and extreme values of the UTCI were considered for the period 2001–2015. She found that all categories of cold stress and almost all categories of heat stress are observed there, but the cold stress conditions prevail. In the largest part of the country, the maximum UTCI values corresponded to slight and strong heat stress.

Krzyżewska and colleagues consider variability of thermal stress in the summer months in Poland in the period 2001–2018. No thermal stress was the most frequently occurring UTCI category (56–75% of summer days) and the moderate heat stress is the second most frequently class (18 to 29%, with the exception of mountain and coastal areas). In general in the years 2010–2018, an increase in the number of days with strong and very strong heat stress was observed and the highest frequency of such days was observed in July.

The researches of Rozbicka and Rozbicki as well as Głogowski and collaborators have used long series of climate data (36 and 50 years) to assess bioclimatic tourism potential of particular regions of Poland: Warsaw and Lower Silesia, respectively. Both researches confirm that no thermal stress category of UTCI is most frequent in annual time scale. However, strong cold and strong heat stress is limited to particular seasons. Observed structure of thermal stress categories was assessed as favourable for tourism.

Thermal stress is influenced by synoptic conditions. This issue is discussed in the paper of Okoniewska. She has used 10 years data (1991–2000) for Warsaw which represents Central European circulation conditions. She discusses daily runs of UTCI in particular seasons and in different synoptic situations. The highest daily variance of biothermal conditions occurs in the spring and autumn when polar continental air mass changes to tropical one (or vice versa). Extreme thermal stress is related mostly with polar continental, arctic and tropical air masses.

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Other factors that influence biometeorological conditions are studied by Błażejczyk and colleagues. The authors discuss how different geographical factors: elevation above sea level, physiographical type of area, climate continentality and location of area in relation to the main mountain ridge influence thermal stress in northern Carpathians. They used data from 21 weather stations in Poland, Ukraine and Slovakia for the period 1986–2015. The results show that (1) cold stress significantly increases and heat stress decreases due to rise of altitude, (2) due to climate continentality and physiographical patterns of northern Carpathians in their eastern edge, the cold stress is more evident than in western one and (3) at southward slopes of Carpathian, heat stress is significantly more frequent than at northward areas.

UTCI is frequently used in climate-human health research. This research area is represented by paper of Kuchcik. The author has analysed daily mortality and meteorological data for 8 large Polish cities for the period 1975–2014. She applied generalised additive models and TBATS models to investigate the relationship between UTCI and mortality and to the evaluation of time series. She has found clear difference in mortality response between cities located in the “cooler” (eastern) and the “warmer” (central and western) parts of Poland. For $UTCI > 32\text{ }^{\circ}\text{C}$, the relative risk of death rose by 10–20% and for $UTCI > 38\text{ }^{\circ}\text{C}$ —by 25–30%. An increase in mortality under extreme cold stress in the “cool” cities is 9–19%.

UTCI characterises thermal stress in humans caused by ambient conditions. However, several researches try to “translate” UTCI to thermal sensations or thermal comfort

assessment. An example of such researches is paper of Kruger and colleagues. Their paper compares thermal comfort ranges for three different locations in Brazil: Belo Horizonte, Curitiba and Pelotas. In each city, a set of outdoor comfort field campaigns were carried out. The results indicate a variation of neutral UTCI up to $3\text{ }^{\circ}\text{C}$ as a possible latitude and local climate effect between the southern and the northern locations. Low UTCI values were found in the two subtropical locations for the lower threshold of the thermal comfort as compared with the original threshold.

The researches presented here cover quite wide range of possible UTCI applications. One should remember that when completing the work on the UTCI, its creators produced a methodological framework covering: the method for calculating the UTCI, the preparation of sets of input data and the basis for interpreting UTCI values, including references to physiological processes occurring in the human body. However, there are still methodological questions which wait for researchers’ response and validation. These problems refer to the following: (1) the availability and quality of meteorological data necessary to calculate the UTCI, (2) the method of calculating the mean radiation temperature, (3) the determination of wind velocity, (4) the interpretation of the UTCI in non-standard applications (various forms of sport, recreation and tourism) and (5) the creation of UTCI distribution maps in local scale. We believe the ongoing and forthcoming researches can soon give the answers.