



Adjustment of tourism climatological indicators for Hungarian population for assessing exposure and vulnerability to climate change

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NAGiS Project, Hungary:

National Adaptation Geo-Information System

- In framework of the 2009–2014 Programme of the European Economic Area (EEA) Grant entitled *Adaptation to Climate Change in Hungary*
- **Goal:** support and foster policy making, strategic planning and decision making related to the impact assessment of climate change in Hungary
- **Input:** climate data, i.e., past observations and future projections
- **Outcomes:** user-friendly geo-information database based on processed data derived from several databases; objective impact studies
→ countrywide, web-based database with reliable indicators

Prototype: in the field of hidrology, natural ecosystems and agriculture

Next step: Extension of NAGiS to other sectors

CRIGiS Project



CRIGiS Project, Hungary:

Vulnerability and impact studies with a focus on **tourism** and **critical infrastructures**

Goals:

- prepare indicators based on existing dataset of the NAGiS and on database to be established newly in the project
- the indicators are used to assess the **exposure** and **vulnerability** due to climate change

Focus on three important sectors:

- heatwave-induced excess mortality
- impacts of extreme weather events on road accidents
- climatic conditions on tourism

Web: kriter.met.hu

Relevance



- SREX (2012): evidence of change in some extremes
- IPCC (2007, 2014): climate change will likely have negative health impacts
- COM (2007): importance of mortality and morbidity due to heat waves
- IPCC (2007, 2014): negative effects on the touristic potential and infrastructure
- Critical infrastructure: number of road accidents significantly increases during extreme weather events

Problem:

No existing and harmonized researches for climate change impacts on different sectors yet in Hungary → elaborate an objective approach

The investigation of such effects should be differentiated on the basis of the vulnerability of the various stakeholders and areas.

Indicators

Exposure:

Applied indicators that quantify the tourism climatic potential:

- Tourism Climatic Index (TCI; Mieczkowski, 1985)
- Climate Index for Tourism (CIT; de Freitas et al., 2008)
- modified Tourism Climatic Index (Kovács et al., 2015)

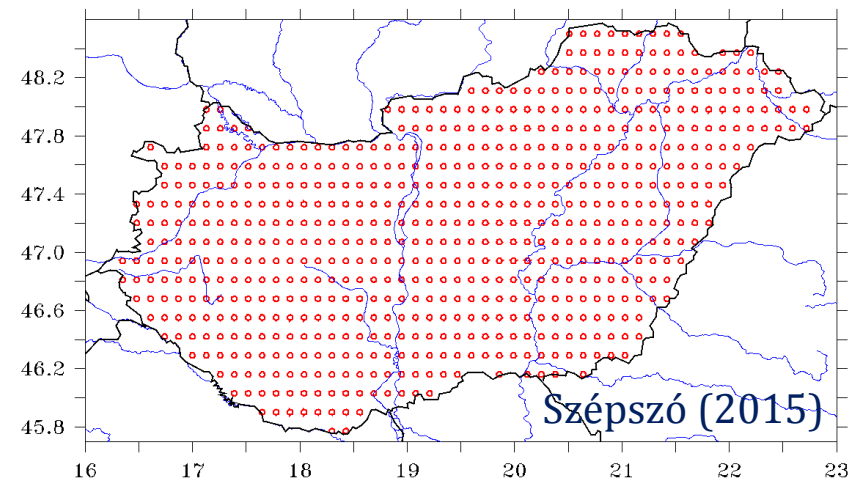
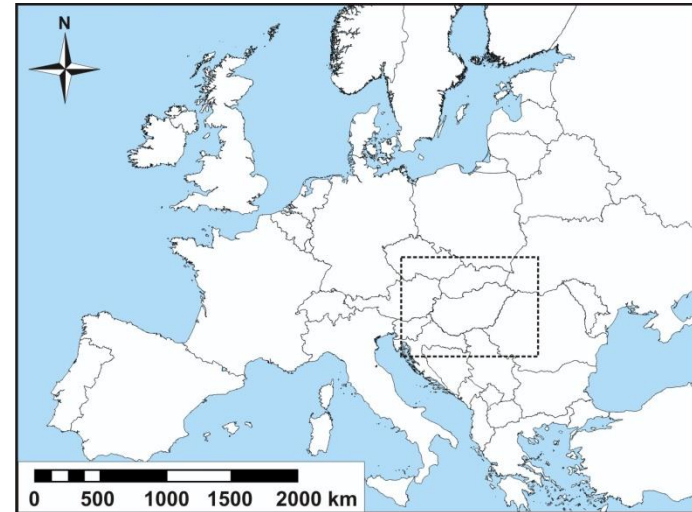
Vulnerability:

Climatic indicators vs. hotel occupancy / visitors in spas, events

Study area

- The TCI, modified TCI and CIT are quantified for the past and **present** based on observed data (1961–1990), and for the **future** (2021–2050, 2071–2100) based on regional climate model outputs
- Applied model: **ALADIN-Climate** (Hungarian Meteorological Service), 10 km horizontal resolution grid, 1104 grid points

Hungary, Europe
(45.8–48.6° N, 16–23° E)



Adjusted indicators

Importance of adjusting climatic indicators

Differences in subjective assessments:

- different physical environment
 - different tourist activities
 - different nationality, place of origin, culture, and attitudes
- ← various levels of physiological acclimatization ← differences in climatic conditions

Thermal environment: differences in thermal perceptions and preferences

Adjusted TCI

Concept of modified TCI:

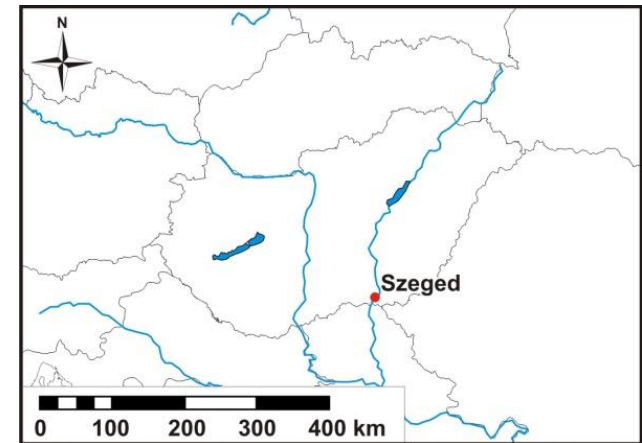
- Adjustment of the thermal comfort sub-indices (daytime and daily comfort sub-index) of the original TCI → **Physiologically Equivalent Temperature (PET)**
- Develop a methodology for the integration of new **PET rating system** into the thermal parts of the TCI (Kovács et al., 2015)
- Express the **subjective thermal assessment** of the Hungarians

SUB-INDEX	CLIMATIC VARIABLES	WEIGHTING
Daytime Comfort Index (CI _d)	Daily max. air temperature, min. relative humidity → daily max. PET (°C)	40%
Daily Comfort Index (CI _a)	Daily average air temperature, relative humidity → daily average PET (°C)	10%
Precipitation (P)	Precipitation sum (mm)	20%
Sunshine (S)	Sunshine duration (hour)	20%
Wind velocity (W)	Average wind velocity (km/h)	10%

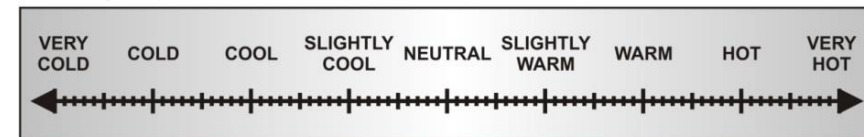
Adjusted TCI

Concept of modified TCI:

- Thermal comfort survey with local population, which involves on-site micrometeorological **measurements** and simultaneous **questionnaire surveys**
- In Hungary: in Szeged (46° N, 20° E), 78 days in spring to autumn of 2011, 2012 and 2015 in six public spaces
→ 6764 questionnaires



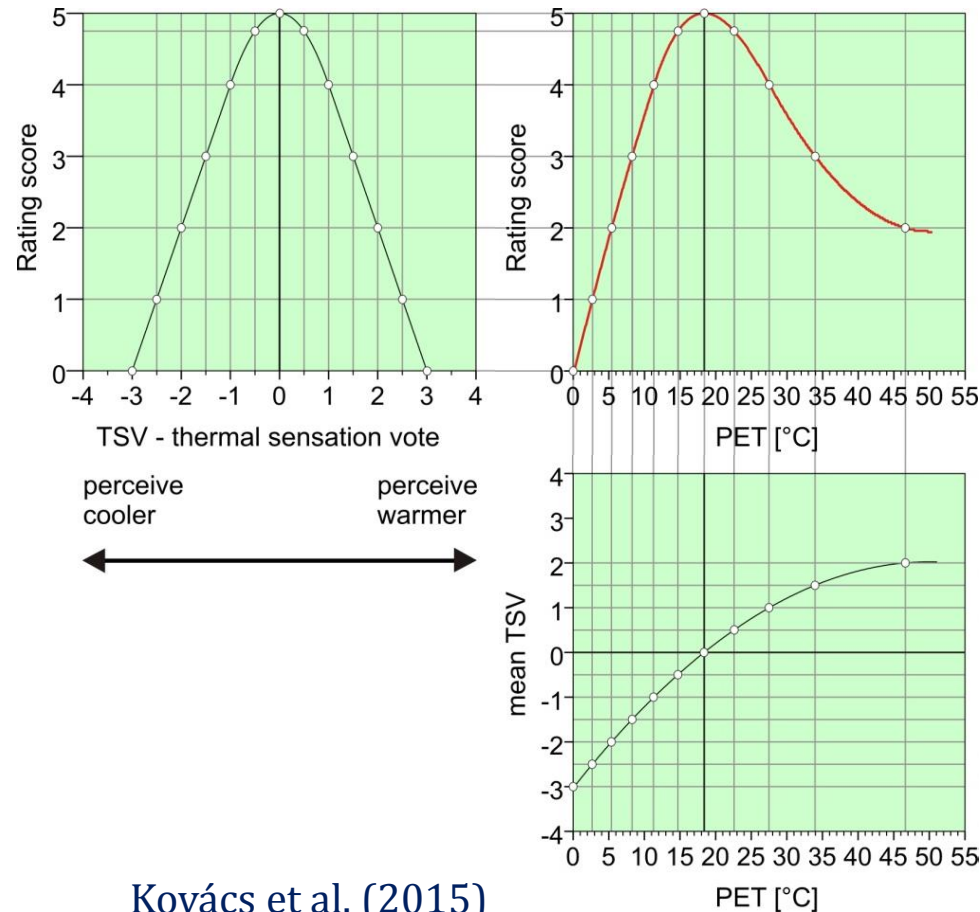
Indicate your thermal sensation on this scale:



Adjusted TCI

Concept of modified TCI:

- Assigning rating scores to PET (*upper right*) with the use of:
 - PET vs. mean TSV regression relationship (*bottom right*) and
 - Thermal Sensation Vote (TSV) vs. rating score (*upper left*) function
- The former can be derived through a thermal comfort survey

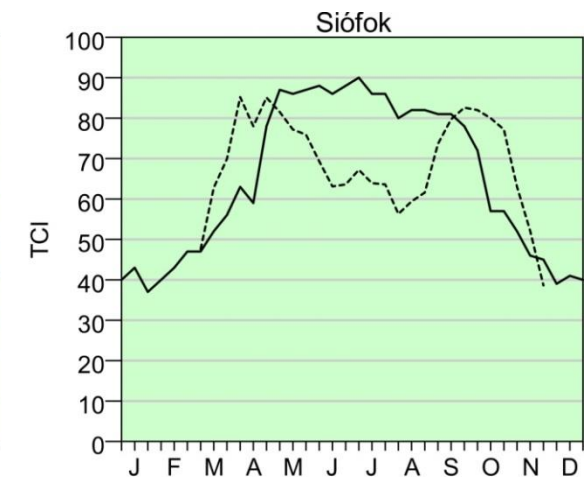
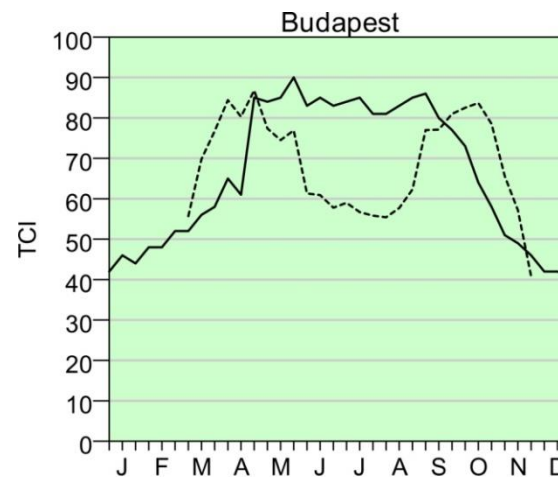
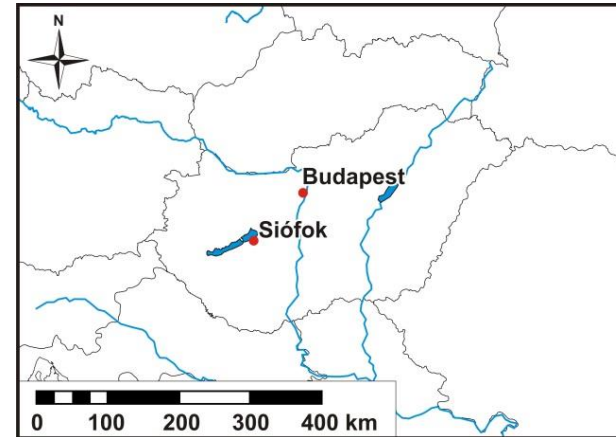


Kovács et al. (2015)

Adjusted TCI – preliminary results

Using TCI and modified TCI through the examples of some tourist destinations:

- Period:
1996–2010
- Data: Hungarian
Meteorological Service
- Original TCI:
summer peak
- Modified TCI:
bimodal structure



— original --- modified

Summary

- Support and foster the development of objective strategic planning and decision making related to the adaptation to climate change in Hungary
- The outcomes of the objective impact studies point out the actions to be taken in order to mitigate or exploit climate change impacts
- The developed indicators in framework of CRIGiS are providing significant support for health care and touristic related services, and are used in investments aiming at enhancing road safety, as well
- Importance of adjusting climatic indicators to the local climate conditions
- Importance of workshops, training of the users





Thank you for your attention!

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