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Impact on Environment and Society

Urban Regions

The Impact of Climate Change on Thermal Comfort in Austrian Cities

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The COIN project evaluates the impact of climate change on the temperature-related well-being of the urban population in Austria and assesses the respective impact in monetary terms.

Main findings

- Under three climate change scenarios (mild, moderate, and strong climate change), the number of so-called urban heat islands will increase throughout Austrian cities in the future; inter alia, this could negatively affect the urban population's well-being regarding heat exposure.
- As the impacts of urban heat islands on costs for adapting to and mitigating heat exposure are highly complex, the current study carries out an indirect rather than a direct monetary impact evaluation (while all other COIN investigations follow a direct approach). For this purpose, the study analyses expenditures for measures that could prevent an increase in heat islands (preventive cost approach).
- Under a moderate climate change scenario, compensating for temperature increase by establishing additional urban green spaces would cause average annual costs of approx. € 127 million (mn) (€ 107mn) for the 2011–2030 (2031–2050) period. However, approx. two thirds of those costs would not be directly climate change related, but would result from less effective ventilation due to urban growth.
- Austrian cities are affected to different degrees; among the federal state capitals, the city of Vienna will face the highest, and the cities of Innsbruck and Klagenfurt the lowest estimated costs.

Due to poor ventilation and the thermal storage properties of built-up spaces, urban areas generally demonstrate higher temperatures than rural environments. Thus, urban heat islands occur where temperatures increase above-average, especially during intense periods of heat. Climate change-related temperature rise would significantly intensify urban heat islands.

Heat islands have many and varied negative impacts. Thus, extremely high temperatures can cause health problems in the urban population (e.g., respiratory and cardiovascular diseases), losses in summer city tourism, and heat-related damages to the transport infrastructure. In urban areas, more frequent periods of heat would generally entail reduced thermal comfort, diminishing the well-being of urban populations.

Project info box

The interdisciplinary COIN (Cost of Inaction – Assessing Costs of Climate Change for Austria) project evaluates economic impacts of climate change in Austria. For this purpose, a scenario-based analysis of and across twelve key sectors is conducted, which assesses the possible impact of climatic change in combination with socioeconomic developments. The main scenario assumes a temperature rise within the two degrees Celsius margin for the period up to 2050. This assumption presupposes stronger climate policies than the ones currently in place. The analyses presented here only show that part of all potential impacts which has already been quantified and takes into consideration individual adjustments made.

What has been analysed?

The current study investigates the increasing heat-related reduction in thermal comfort throughout urban centres in Austria. The preventive cost approach was chosen to evaluate the expected impacts in monetary terms. Assuming that green spaces have a cooling effect on urban climates[1], the study has calculated how much additional future green space would hypothetically be required throughout the six largest cities in Austria to keep thermal comfort at the current level under changed climatic conditions. The respective necessary expansion of green spaces has been evaluated in monetary terms. Choosing such an approach neither means that this specific adaptation option is the best one, nor that the actual damages occurring (should these measures not be implemented) will not be quite different (and more serious). Especially impacts on health, damages to the infrastructure, and impacts on tourism are not taken into consideration. However, the calculated costs at least represent a first point of reference.

1 Studies show that city parks are 3 to 6 °C cooler than the surrounding built-up areas (e.g., Gill et al 2007, Oliveira t al. 2011, Loibl et al. 2014).

What impacts are to be expected?

Under a moderate climate change scenario[2] and moderate socio-economic developments[3], the study shows that between 2011 and 2030 (2031 and 2050) an additional 195 (143) hectares of green spaces as well as 4,300 (4,500) newly planted street trees would hypothetically be required throughout the six cities under examination to maintain the current level of thermal comfort. However, approx. two thirds of the respective green spaces and trees would be required as a result of reduced ventilation due to the anticipated expansion of densely built-up urban areas, rather than as a result of climate change.

The hypothetic annual average capital expenditure for additional green spaces amounts to € 120 mn (€ 94 mn) for the 2011–2030 (2031–2050) period. Including maintenance and operating costs, the total expenditure amounts to € 127 mn (€ 107 mn) for the 2011–2030 (2031–2050) period. The lower costs for the later period of analysis result from lower estimated urban growth compared to the first period.

Are there regional variations throughout Austria?

The study shows that Austrian cities will be affected differently due to their size and regional differences in frequency and magnitude of heat episodes. While Innsbruck and Klagenfurt can expect total capital expenditures of less than € 100 mn by 2050, Linz, Salzburg, and Graz would face twice the respective costs. At approx. € 4 billion, Vienna would encounter the highest expenditure for urban greening measures – owing, inter alia, to a higher absolute demand for urban green spaces (despite lower relative urban growth in spatial terms) and to higher real estate prices than in the other state capitals.

Do alternative projections for the future change the results?

Alternative projections of climate change intensity have an impact on the hypothetical demand for additional urban green spaces and lead to changes in economic impact (always assuming consistent urban growth). Thus, compared to moderate climate change, under a mild climate change scenario the average annual costs would decrease to € 108 mn (€ 75 mn) for the 2011–2030 (2031–2050) period (see Table 1). Strong climate change, on the other hand, would result in costs of € 166 mn (€ 172mn) during the 2011–2030 (2030–2050) period.

2 Comparing the reference period (1981–2010) to the first (second) scenario period of 2016–2045 (2036–2065), the moderate climate change scenario projects a mean temperature rise of +1.0 °C (+2.0 °C), changes in annual precipitation sums of +1.4 % (-2.3 %), and changes in the number of days with precipitation of +2.1 % (3.5 %).

3 Based on the ÖROK prognoses for population and housing, densely built-up areas in the federal capitals and in Vienna, respectively, will increase by 9 % to 14.8 % (4 % to 7 %) over the 2011–2030 (2031–2050) period.

4 The result is based on comparing the moderate climate scenario to a baseline scenario (which examines the sector under moderate socio-economic developments and no climate change).

Table 1: Average annual economic impact of an additional demand for urban green spaces in Austrian cities (in million €).

Future economic impact*			Climate change		
			mild	moderate	strong
Ø 2011-2030	Socio-economic development (sensitivity**)	medium	-108	-127	-166
Ø 2031-2050		medium	75	-107	-172

* Future economic impact: negative numbers indicate net losses, positive numbers indicate net gains, n/a: data not available.
**Result sensitivity with respect to socio-economic development parameters.

What impacts on the Austrian national economy are to be expected?

Due to the specific approach of the evaluation (preventive cost approach), cross-sectoral impacts and impacts on the overall economy could not be analysed, as the study investigated hypothetical and not actual expenditures. However, when we assume publicly funded compensation or adjustment measures for damages due to an increase in urban heat island and estimate them at the level of preventive costs (capital expenditure and maintenance costs for additional green spaces), we can deduce the impact of the financing burden on the gross national product (GNP). Under moderate climate change, public funding for compensation would cause the gross national product to annually decrease by € 24 mn (€ 38 mn) for the 2016–2045 (2036–2065) period.

References

Gill S, Handley J, Ennos R, Pauleit S. 2007. Adapting cities for climate change: The role of the green infrastructure. Built Environment, 30/1: 97–115.

Loibl W, Stiles R, Pauleit S, Hagen K, Gasienica B, Tötzer T, Trimmel H, Köstl M. 2014. Improving Open Space Design to Cope Better with Urban Heat Islands Effects. GAIA 23/1: 64–66.

Oliveira S, Andrade H, Vaz T. 2011. The cooling effect of green spaces as a contribution to the mitigation of urban heat: A case study in Lisbon. Building and Environment 46: 2186–2194.

Loibl W, Tötzer T, Köstl M, Nabernegg S, Steininger KW. 2015. Cities and Urban Green, Chapter 17 in: Steininger KW, et al. (eds.), Economic Evaluation of Climate Change Impacts: Development of a Cross-Sectoral Framework and Results for Austria. Vienna, Springer.

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