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Impact of regional afforestation on climatic conditions in metropolitan areas: case study of Copenhagen

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Like most other places, European metropolitan areas will face a range of climate–related challenges over the next decades that may influence the nature of urban life across the continent. Under future urbanization and climate change scenarios the well-being and comfort of the urban population might become progressively compromised. In urban areas, the effects of the warming climate will be accelerated by combination of Urban Heat Island effect (UHI) and extreme heat waves. The land cover composition directly influences atmospheric variability, and can either escalate or downscale the projected changes. Vegetation, forest ecosystems in particular, are anticipated to play an important role in modulating local and regional climatic conditions, and to be vital factor in the process of adapting cities to warming climate.

This study investigates the impact of forest and land-cover change on formation and development of temperature regimes in the Copenhagen Metropolitan Area (CPH-MA). Potential to modify the UHI effect in CPH-MA is estimated. Using 2009 meteorological data, and up-to-date 2012 high resolution land-cover data we employed the online integrated meteorology-chemistry/aerosols Enviro-HIRLAM (Environment – High Resolution Limited Area Model) modeling system to simulate air temperature (at 2 meter height) fields for a selected period in July 2009. Employing research tools (such as METGRAF meteorological software and Geographical Information Systems) we then estimated the influence of different afforestation and urbanization scenarios with new forests being located after the Danish national afforestation plan, after proximity to the city center, after dominating wind characteristics, and urbanization taking place as densification of the existing conurbation. This study showed the difference in temperature up to 3.25°C, and the decrease in the spatial extent of temperature fields up to 68%, depending on the selected scenario. Performed simulations demonstrated that well-positioned and well-sized afforestation at the regional scale can significantly affect the spatial distribution, structure and intensity of the temperature field. This study points to vegetation having practical applications in urban and regional planning for modifying local climatic conditions.

Keywords: Urban Heat Island, Afforestation, Land cover change, Urban planning, Climate change adaptation, Enviro-HIRLAM