6.3 LOCAL COLD AIR AND ITS SIGNIFICANCE FOR THE URBAN CLIMATE

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1. INTRODUCTION

Local cold air is an important factor in urban planning practice in Germany. In the case of the human-biometeorological aspect considered here, the positive effect of local cold air is seen in an improvement in the thermal and air quality complex, for example during low-exchange weather situations in the form of cold air supply to cities by country breezes (BARLAG & KUTTLER 1991). In order to provide a well-founded physical basis for argumentation with local cold air as a planning factor, a guideline entitled "local cold air" was recently issued by the Commission of Air Pollution Prevention of VDI (Verein Deutscher Ingenieure) and DIN – Standards Committee (KRdL; Subdivision II "Environmental Meteorology") chaired by the author (VDI 3787, PART 5). In the KRdL, experts from science, industry and administration establish VDI guidelines and DIN standards in the field of environmental protection. These describe the state of the art in science and technology in Germany and serve as a decision-making aid in the preparatory stages of legislation and the application of legal regulations and ordinances. The working results of the Commission on Air Pollution Prevention are also considered as the common German point of view for the establishment of technical rules at the European level by CEN (European Committee for Standardization) and at the international level by ISO (International Organization for Standardization).

2. DEFINITION OF "LOCAL COLD AIR"

The term "local cold air" is used to refer to a locally limited volume of near-surface air which is colder than its surroundings and is not cooled in connection with the passage of a front. The cold air temperature stated is therefore a relative value rather than an absolute temperature. Cold air is mainly created with a negative radiation balance at the surface and low atmospheric concentrations of infrared-active trace substances during clear low-wind nights. Cold air formation depends on the vegetation, topography and exposure of the ground surface as well as the short and long-wave albedo and the thermal conductivity and heat capacity of the soil. Cold air productivity has pronounced diurnal and annual courses. The volume of cold air per unit surface area and time is used as a measure. In this context, it is problematical that there are no threshold values for the severity of cooling or for the size of the air volume which must be reached before we can speak of cold air. Cold air can therefore be characterized both by the degree of cooling and by the air volume concerned. In accordance with the conventions adopted, cold air productivity is normally characterized by the volume of cold air.

3. FUNCTION AND TARGET GROUP OF THE "LOCAL COLD AIR" GUIDELINE

The purpose of this guideline is to ensure that local cold air is given due consideration in local and regional planning and environmental impact assessments. The objective is to achieve the formal quality required for local cold air targets under the planning laws of the German States, the Construction Code (BauGB), the Federal Nature Conservation Act (BNATSCHG), the Environmental Impact Assessment Act (UVPG) and the large number of other applicable laws.
This guideline is addressed to climatic assessors and planners. It is intended to provide the objective basis required for the assessment of local conditions, the physical parameters and the human-bioclimatic effects of cold air in the planning process. For example, the positive human-biometeorological effects of cold air must be taken into consideration and used for the planning of residential developments, trading estates, industrial facilities, roads, power stations and other projects. It is also possible or even necessary to reinforce the positive effects of cold air when rehabilitating and converting existing facilities. When extending existing developments and plants or planning new projects, the negative impact on cold air must be minimized.
The guideline is closely connected with other guidelines relevant to urban planning such as the VDI 3787, PART 2, for human-biometeorological aspects and the VDI 3787, PART 1, which defines criteria for the production of climate and air quality maps for cities and regions.

4. STRUCTURE AND CONTENT OF THE "LOCAL COLD AIR" GUIDELINE

The guideline consists mainly of five sections dealing with the following subjects:

- cold air generation (*prerequisites for cold air generation over various surfaces, effects of changes in land use on cold air generation*),
- cold air flow (*flow conditions, effects of obstacles*),
- air quality, biometeorological and technical effects,
- ensuring cold air generation and flow, planning relevance (*assessing the effects of interventions*),

- recommendations for investigation conditions (*objectives and methods, requirements for numeric and physical models*) and
- research requirements.

5. PRESENTATION OF INDIVIDUAL ASPECTS

There are wide variations in cold air production rates (VDI 3787, PART 5). It is now normal practise to use a value of 12 $m^3/(m^2 . h)$ in German planning procedures (KING 1973). In most planning projects, the cold air productivity of a surface is assessed only on the basis of the land utilization type and the conditions of the individual case are not taken into account. Estimates of these types are often used as input data for numeric simulations. The misinterpretation of the results obtained in this way is often the unavoidable consequence.
Major influences on cold air dynamics include topographic and orographic factors, densely packed rows of tall trees and bushes, building structures and road and rail embankments which determine the intensity and direction of cold air flow or cause cold air accumulations, for example at obstacles. Areas with vegetation may lead to widely differing cold air production rates depending on the type and density of vegetation and the gradient. For example, the cold air flow and the volume transported from a wooded area interrupting air flow on a hill may be significant but the cooling effect may not be very intense. In an urban area, cold air can only have a positive effect if it originates from an area which is not contaminated by pollutants or odours and is connected to the urban area via appropriate air flow channels (MATZARAKIS & MAYER 1992). The question of air quality for the urban area can be answered on the basis of thermal (PMV = Predicted Mean Vote; PET = Physiological Equivalent Temperature; pt = perceived temperature) summary in KUTTLER (1999)) and air quality indices (air pollutant and odour limits and guidelines, VDI 3788, Part 1; VDI 3787, Part 3. However, problems arise because there is still no air quality index which takes into account the total concentration of all trace substances measured and can be used as an overall measure of air quality.

Work on the guideline has also clearly shown that there is considerable need for research especially in the area of cold air generation, flow and assessment. Questions which will need to be clarified as a matter of priority include the cold air temperature, the volumes produced and the cold air catchment areas that are required. Attention should also be focused on the areas of cold air-producing green spaces required in inner cities with a view to obtaining an indication of the ventilation relevance of these areas for the surrounding built-up areas.

6. REFERENCES

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