RESEARCH AND PROJECTS FOR PROTECTION, MANAGEMENT AND LANDSCAPE DESIGN
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Thermal comfort and its significance for landscape practice

There is a clear role for landscape architects to ensure the liveability of cities is maintained even during extremely hot weather by considering thermal comfort and developing city-scale heat resilience strategies.

Introduction

Here in northern Europe, much as we enjoy sunshine and look forward to warm summer weather, particularly in the dreary months of late winter, it can be too much of a good thing. June 2022 saw some of the hottest temperatures ever recorded in the UK. On the hottest day, June 17, there were 638 excess deaths attributed to heat in England (Booth 2023). The effect of heat waves on health and wellbeing has been well documented, particularly among vulnerable groups such as the young, the old and those with existing health conditions. The debilitating effect of lack of sleep on hot nights has an influence on productivity, as well as the ability to learn, and can affect safety for those using machinery, including driving cars, although these effects are difficult to quantify. The association of hot weather with change in behaviour is evident from the term 'hot headed' and the Heat Hypothesis predicates that hot weather leads to an increase in violent crime (Anderson-Mahendran et al 2021). This association is attracting renewed attention as heat waves become more frequent and intense, but of wider importance is the effect on everyday activities in a city and the need for urgent action for this environment to remain welcoming, even with high climatic temperatures.

Hot weather can result in a significant drop in the number of visitors to city centres as they are exposed to heat stress there (Spanjar et al 2022a), so less money is spent on non-essential purchases. Staying indoors in poorly insulated homes is often uncomfortable and this may force people to go to cooler areas such as parks, the countryside or coast. Public transport may become a less attractive option, particularly when waiting areas such as bus stops or station platforms are open and lack shade. This can cause increased car use (Pazdan 2020). Cycling is a more sustainable transport option but, like other forms of physical activity, this is sensitive to warm conditions (Böcker and Thorsson 2014. Walking in the sun can also become unpleasant in hot weather, although there may be no alternative for those needing to travel to work, school or for daily shopping. Extreme weather events, including heat waves, are predicted to become more frequent, more intense, and longer lasting with local authorities increasingly aware of the need for urgent action. A recent Nature paper highlighted this suggesting not only specific policies to deal with extreme temperature were required, but heat officers should be appointed to ensure the safety of vulnerable groups and individuals (Ladd et al 2021).

The Cool Towns project

Funded by the European INTERREG 2 Seas programme this was a four-year project involved local and regional authorities from the UK, Belgium, France, and the Netherlands. These were assisted by researchers from the University of Greenwich and Amsterdam University of Applied Sciences, as well as companies specialising in climate mitigation, to find the most effective cooling options for different types of public open space and to collate research findings to provide a roadmap for

towns and cities to develop their own heat resilient strategies. The following sections describe the steps in this roadmap.

What is heat stress?

The Physiologically Equivalent Temperature (or PET) index was used as this is the most appropriate standard measurement system to identify and express the thermal comfort experienced in outdoor spaces. A pre-requisite in including heat stress mitigation in urban design is to understand the consequences for individuals as well as the potential economic impact. There is significant information available on the health implications and the need to avoid exposure (e.g. Wong 2023) and this section includes suggestions for a participatory approach to introducing this important aspect of the changing environment to decision makers, such as elected representative, who might not previously have considered it a priority.

What places have heat stress potential?

The second step is to identify places with high intensity of use and where particularly vulnerable people might experience discomfort and possible health risk, during hot weather. The academic partners developed a standardised Thermal Comfort Assessment (TCA) to identify where in partner towns or cities would be most likely to become unbearable hot during summer days (Spanjar et al 2020). The Urban Heat Atlas (Spanjar et al 2022a) is the result of four years research and contains heat-related maps of urban areas, covering more than 40,000 hectares in ten municipalities in England, Belgium, the Netherlands, and France. The maps demonstrate how to conduct a Thermal Comfort Assessment (TCA) systematically to identify heat vulnerabilities in cities to enable decision-makers to set priorities for action. The comparative analysis is the first overview of the current heat resilience state of cities in Northwest Europe.

The Atlas begins by identifying the impact of heat in the Cool Town's project partner's cities contains a collection of heat maps developed for these urban areas to set priorities for action where heat stress was most likely to be experienced. The maps were developed by modelling the effect of different meteorological scenarios, combined with social and environmental indicators, to enable priorities for intervention in partner cities to be set. For instance, users of market squares and other open central locations are frequently exposed to direct solar radiation, but their multiple functions and/or heritage status can hinder mitigation attempts. This can be addressed by transforming nearby parking areas into green oases to provide relief by creating cool spots.

The heat maps for coastal cities (Southend and Ostend) show that visitors are, on hot days, exposed to extreme conditions even before they reach the beach. Walking routes from parking areas and transport hubs to the sea can be cooled by creating green promenades and nearby parks, such as the Westcliff Parade in Southend, and these may offer cool alternatives on hot days when staying at the beach for long periods is uncomfortable.

How can heat stress be reduced?

Main routes for cycling and walking can be transformed into cool corridors by planting rows of trees, and this can secure the accessibility of important areas in the city. There are, however, some disadvantages to consider as trees require careful management, especially during establishment, and can incur additional costs, such as watering, pruning and autumn leaf clearance. Long-term investment in tree planting and management to increase canopy cover is the most effective way to address the Urban Heat Island effect and make cities more heat resilient. Shade sails are an effective alternative for immediate effect, such as can be required for play areas or narrow streets where planting trees is not possible and these can reduce Physiological Equivalent Temperature (known as PET, the way heat stress is measured) by 9-15°C. Water features have little effect on PET, with reductions of 0-6°C experienced, but only by those close to them. However, contact with the

water cools immediately and this works particularly effectively for children. Green walls are increasingly popular, but PET reduction is negligible and only noticeable when close to them - although they insulate buildings so can increase thermal comfort for those inside.

What is the best option to reduce heat stress in your area?

The results of all the measurements carried out by the partners have been collated in the Cool Towns Intervention Catalogue (Spanjar et al 2022b), the third in the series of documents produced by the project. This enables the costs and benefits of different heat stress mitigation options to be compared and considered in site-specific contexts, so the most appropriate can be selected. The Intervention Catalogue has been designed as a resource for decision-makers, urban planners, landscape architects, environmental consultants, elected members, and anyone considering how to mitigate heat stress and increase thermal comfort in urban areas. Technical information on the effectiveness of the full array of intervention types, from trees to water features, shading sails to green walls, is provided for their heat-stress mitigation properties, expressed as the measured reduction in Physiological Equivalent Temperature (PET). These factsheets will help in making an informed, evidence-based choice so that the most appropriate intervention for the specific spatial situation can be identified (Spanjar et al 2022b).

Case studies

All the local authority partners in the Cool Towns project carried out pilots – from tree planting to installing water features and green walls – so that effectiveness in heat-stress mitigation and improved thermal comfort for users could be documented. All of these have been written up as case studies and are available on the Cool Towns website (https://www.cooltowns.eu/case-studies/). These provide information about the decision-making journey, technical details as well as capital and maintenance costs and reaction from the public. Trees deliver many well-established, benefits and can also reduce the temperature experienced by between 4 and 20°C PET, although this depends on the leaf area, which provides shade, as well as ambient weather conditions that affect evaporation. In some case studies the trees were planted in combination with sustainable drainage systems (SuDs) so had the additional benefit of mitigating surface water flooding.

Developing a city-wide strategy

Taking all the elements described above together forms a roadmap to enable a city-wide heat resilient strategy to be developed and this is something that is becoming increasingly urgent. The Cool Towns website provides summaries of the relevant legislation and policy for the countries involved and demonstration examples of strategies to encourage others to create their own. The roadmap outlines the approach, from start to finish, to producing a heat-resilient city strategy, as well as all the elements within it that form a decision support toolkit.

What does this mean for landscape professionals?

There is a clear role for landscape architects to ensure the liveability of cities is maintained even during extremely hot weather by considering thermal comfort and developing city scale heat resilience strategies. This requires systemic change, going beyond evaluating the cooling potential of existing green infrastructure, but considering how cool spaces can be distributed more equitably, providing benefit where it is most needed. Total green cover positively influences the urban heat island effect – the greener the city, the cooler it is – but deprived neighbourhoods frequently have less green space than more affluent ones, so cooling capacity is inadequate where people have least resources. It is at the street level that strategically placed small-scale interventions can improve the microclimate providing cool areas to keep important amenities accessible during hot days.

All the outputs of the Cool Towns project can be seen on the website, www.cooltowns.eu/.

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Abstract

The Cool Towns project, funded by the INTERREG 2 Seas programme between 2018 and 2022, was a partnership between local authorities, universities and commercial companies from England, Belgium, France, and the Netherlands, who collaborated to develop an evidence-based toolkit to enable heat stress mitigation to be included in both new developments and upgrading schemes. Heat waves are increasing in frequency, duration, and intensity and this, combined with urban densification contributes to the Urban Heat Island effect and reduces the liveability of cities. The Urban Heat Island effect is well known; cities experience higher temperatures than the surrounding

countryside, especially at night. This has real impact on city life, for example, on residents' health, the local economy and sustainable mobility Understanding the full impact of heat waves, specifically identifying the most vulnerable areas to heat stress, and integrating heat resilient strategies, is new and urgently needed. Increasing vegetation can help reduce heat stress at night as well as during the day and there are numerous examples of city-wide initiatives to increase canopy cover. However, until now, there has been little research into the relative effectiveness of different tree species and other interventions on thermal comfort. This paper will introduce the components of the Roadmap, developed during the project, to help towns and cities develop a heat resilient strategy.