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Blue & Green Infrastructure

In this issue

The 'Cool Towns' Project: Using Green/Blue Infrastructure to Reduce Heat Stress in Public Open Spaces

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This paper describes the emerging concern about the impact of heat stress on people in urban areas and how this is being used as an additional factor in promoting Green and Blue Infrastructure.

Bird nesting in a textile-based wall made by Sioen Industries, Belgium, spring 2019. © Sioen Industries NV – GreenTecStyle.

Introduction

As environmental professionals we promote Green and Blue Infrastructure (GBI) for the wide range of well-established, associated benefits, and particularly for providing wildlife habitat. There is growing interest in taking an integrated and wide-ranging approach encompassing multiple ecosystem benefits including those relating to human health, which we usually consider as promoting exercise, general wellbeing and minimising stress. Planting trees to sequester CO_2 as mitigation for climate change is found in many policies and strategies and the idea of Nature-based Solutions (NbS) is gaining traction but how often is the role of Green and Blue Infrastructure in mitigating local climate-induced impact on people mentioned?

The impact of low temperatures in raising mortality during winter cold spells is well established but that of heat stress is emerging as an issue for policy makers and, particularly, town planners, architects, landscape architects and environmental managers. The European Environment Agency (2016) has collected data which has revealed that there has been a substantial increase in heat waves in recent decades, with records broken in 2006, 2007, 2010, 2013, 2014 and 2015, causing tens of thousands of premature deaths in Europe since 2000. The summer of 2003 was an outstanding example with an estimated 70,000 premature deaths; summer 2015 saw more than 3,000 deaths in France alone. The report goes further to state that it is virtually certain that as the duration, frequency and intensity of heat waves increases this will result in increased mortality, especially in vulnerable groups, unless adaptation measures are taken.

Heat stress

When considering the impacts of heat stress on people, there are two phenomena that need consideration.

1. Climate change – The UK Climate Change Risk Assessment 2017 Evidence Report, in the Technical chapter on People and the Built Environment, predicted that the number of heat-related deaths in the UK will increase by around 250% by the 2050s based on the median estimate (Kovats and Osborn 2016). The 2018 Intergovernmental Panel on Climate Change report (IPCC 2018), with the announcement that there are just 12 years left if we are to avert catastrophic temperature rise, has further heightened awareness of the possible scenarios of impact from climate change induced temperature rise and the impacts for human wellbeing.

In this context, local authorities are taking this issue very seriously, as evidenced by publications such as *Rising to the Climate Crisis – A Guide for Local Authorities on Planning for Climate Change* (Town and Country Planning Association 2018), and

policies for climate change mitigation will soon be included in strategic plans. This is a key opportunity to promote the importance of Green and Blue Infrastructure both at the wider, landscape-scale of parks and rivers as well as on individual sites. In this article we describe two projects focusing on initiatives to mitigate heat stress at landscape and local scales.

2. Urban Heat Islands – Urban Heat Islands (UHI) are the 'characteristic warmth' (Voogt 2004) which develops several hours after sunset in the densely built, central parts of cities (Figure 1). The cause of the Urban Heat Islands effect is complex but a key component is the density of buildings, which can reduce air flow and funnel wind through the 'canyons' made by narrow, high-sided streets. The geometry of the built environment also reduces 'sky view', the degree of openness to the atmosphere that allows heat to dissipate. In addition, many building materials absorb and store heat, releasing it when the air temperature drops as the sun goes down in the evening. It is this that leads to the high night-time temperatures that make it difficult to sleep and can adversely affect the old, the young and otherwise vulnerable groups.

Why is heat stress important?

Recent studies have looked at the impact of heat stress on economic productivity and output. A working paper by the Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Costa *et al.* 2016) estimated that in a warm year in the far future (2081-2100), economic losses due to heat stress and lower productivity would be 0.4% of Gross Value Added (GVA) for London corresponding to total losses of around €1.9 billion for London.

The Urban Heat Island map in Figure 2 shows the results of an 'UrbClim' simulation (*https://vito.be/en/product/urbclim-urban-climate-modelling)* for the mean temperature at midnight during the summer of 2011 (May to September) at a resolution of 250 m. This year was selected as a typical summer for a West-European city. On average, the night-time temperature is approximately 4°C higher in the city centre compared to rural locations. During some hot nights, even larger effects are observed.

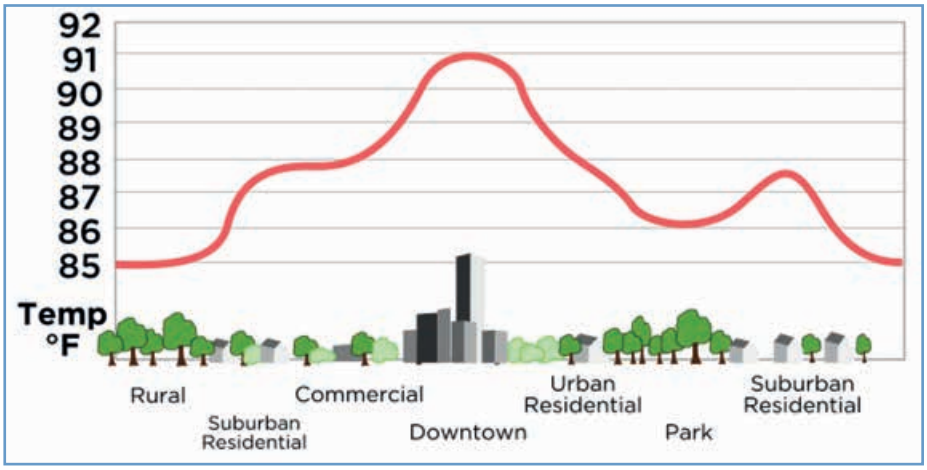

Figure 1. Urban Heat Island: typical temperature profile. Source: https://www.worldatlas.com/articles/urban-heat-island-causes-and-consequences.html

The potential benefits of Green and Blue Infrastructure for mitigating heat stress in the urban environment are clear but surprisingly little real evidence exists quantifying – and so justifying investment in – the effect of different interventions. When considering how to reduce heat stress in an open square, for example, should trees be planted or would a water feature be more effective?

The Cool Towns Project

This project began in September 2018 and is funded until 2022 by the European INTERREG 2 Seas programme (https://www.interreg2seas.eu/nl/cooltowns).

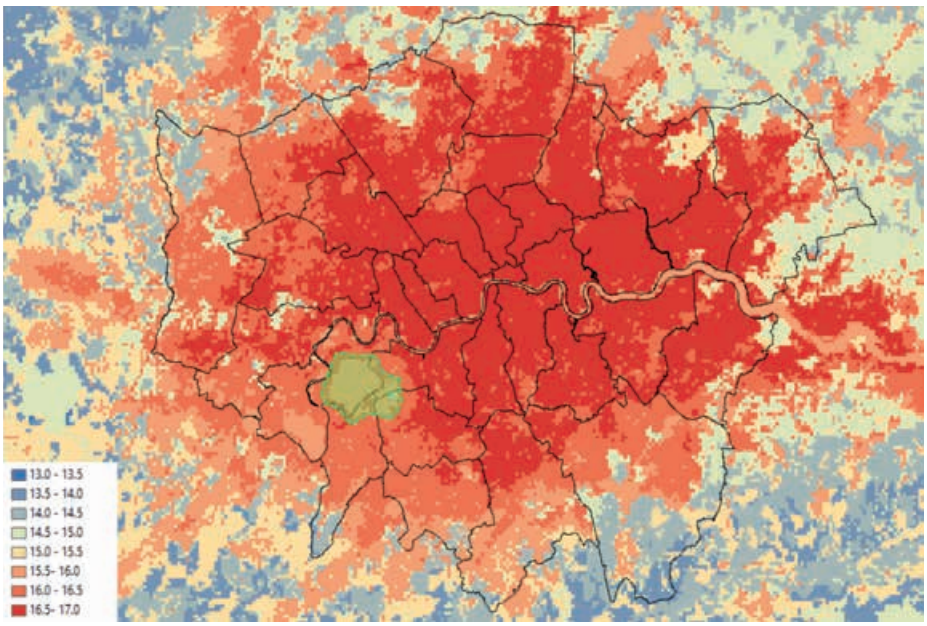

Figure 2. London's Urban Heat Island showing average summer temperatures in 2011. Colours represent the temperature gradient from a high (red) of 17°C to a low (dark blue) of 13°C. The effect of the built environment on temperature is clear with the mitigating impact of Green and Blue Infrastructure clearly illustrated by the lower temperatures around Richmond Park in South West London, with the extent of this effect shown by the dashed green line
Source: Dataset available on the London Datastore. The mapping project was carried out by VITO (Vision on Technology for a Better World, https://vito.be/en) using an 'UrbClim' simulation (https://vito.be/en/product/urbclim-urban-climate-modelling) as part of an EU-funded RAMSES programme (http://www.ramses-cities.eu) on the urban impacts of climate change.

It has been set up to assess the effectiveness of different interventions at mitigating heat stress. The subtitle is *Spatial Adaptation for Heat Resilience in Small and Medium Sized Cities* with partners from Belgium, France and the Netherlands as well as the UK, with University of Greenwich as a member of the scientific advisory team. The focus is on public open spaces where people experience heat stress during hot weather and there are associated economic costs, particularly to urban businesses such as retail outlets which people are less likely to visit when the temperature outside is uncomfortable. The effect of a range of interventions, both existing, new and pilot installations, will be measured to provide data on both actual impact on temperature and on perceptions of heat stress.

Developing a decision support tool

Given the general lack of data, planners are unable to factor in mitigation for heat stress when considering the costs and benefits of urban design options. One of the outputs from the Cool Towns Project will be a decision support tool that compares different Green or Blue Infrastructure interventions in site-specific contexts enabling the most appropriate design for the situation to be identified. All the project partners are collecting data on installation and – importantly – ongoing maintenance costs as well as measuring actual effects following a standardised protocol using instruments provided by the project. This evidence of the impact of green/Blue Infrastructure on local microclimates will be combined with information on co-benefits (aesthetic, biodiversity, air quality and general wellbeing effects) to inform decisions and investment.

Some interesting examples are emerging. While there are many benefits associated with tree planting, the main impact of trees on heat stress is the provision of shade. Evapotranspiration, often stated as a cooling mechanism, is less effective as plants tend to close stomata to reduce water loss during hot periods. It is interesting to see how different partners in the Cool Towns Project manipulate trees to maximise shade. Figure 3 shows plane trees in the Netherlands, in winter and in summer, demonstrating how to maximise shade provision – but how acceptable would this be in the UK? And how many local authorities, in these times of austerity, would contemplate such an intensive tree management regime?

Green walls and facades are becoming more popular despite the capital and maintenance costs. Many claims are made about the benefits in terms of reducing pollution, improving air quality and reducing noise but, although the insulating effects on internal building temperature is well established and they certainly improve the appearance of buildings, what impact do they have on reducing outdoor temperatures? Recent tests in Italy showed that on a hot summer's day the difference in temperature (monitored on the external surface) between the bare wall and the covered wall ranged from 1°C to 20°C (Mazzali *et al*. 2013) and has the potential to reduce cooling load by over 30% (Djedjig *et al*. 2016). At an urban scale, the use of green walls is considered more beneficial than cool paints as, rather than reflecting radiation (which may be intercepted by other buildings), radiation is absorbed and dissipated by evapotranspiration. However, data is sparse and to complicate matters further there are many different systems, some textile based, others box systems, but the benefits for wildlife, particularly insects and birds, are clear (Figure 4).

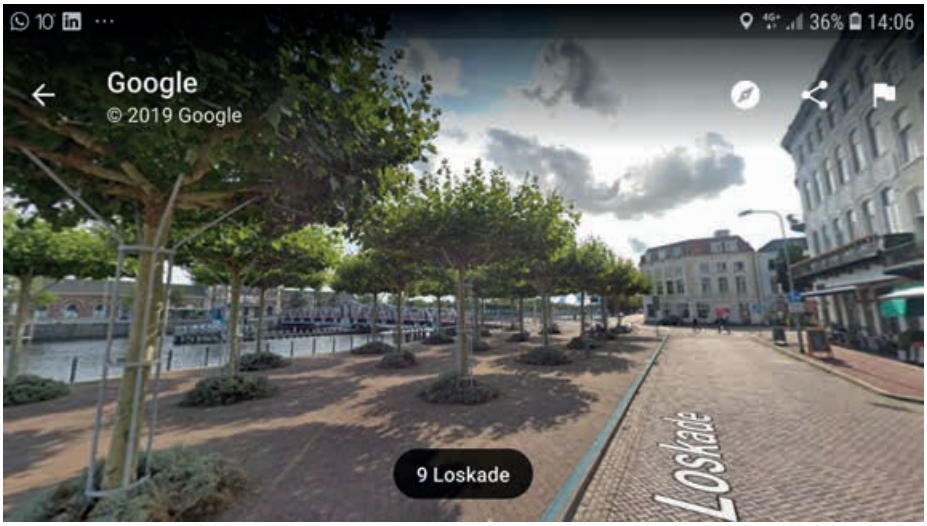

Figure 3. Plane trees in Middleburg, the Netherlands, (left) in winter and (below) summer, pruned and trained to maximise shade.

There is greater awareness of the multiple co-benefits afforded by Blue Infrastructure, including mitigation of heat stress, enhancing resilience to flooding and climate change and providing wellbeing benefits but there is even less data than for Green Infrastructure. Water features are well liked by the public and specific sites have been selected in the Cool Towns Project to collect information on the costs and benefits. Research suggests that rivers can have a significant cooling effect with an average reduction of 1°C found up to 30 metres away from the riverbank during temperatures higher than 20°C (Hathway and Sharples 2012). This effect was negligible at 40 metres although where streets are open to the river, air flow combined with vegetation can increase effective cooling.

The decision support tool will include a review of the scientific and grey literature as well as direct measurements of PET (potential evapotranspiration) from a wide range of Green and Blue Infrastructure interventions. When completed, it will be freely available in all the four languages of the partner countries and is likely to be web based.

Figure 4. Bird's nest in a textile-based wall made by Sioen Industries, Belgium, spring 2019. © Sioen Industries NV – GreenTecStyle.

Co-benefits (or ecosystem services)

The conventional rationale for promoting Green and Blue Infrastructure is for biodiversity, health and wellbeing, with the latter being focused on aesthetic aspects, mental health and exercise; nevertheless, the need for heat stress mitigation is emerging as a powerful driver to support the promotion of Green and Blue Infrastructure to policy and decision makers. The most interesting aspect of the Cool Towns Project is the opportunity to raise awareness of the wider or co-benefits of Green and Blue Infrastructure for humans, wildlife and the environment in general. All the partners have been running workshops taking decision-makers (planners, facilities/maintenance managers, architects, and the like) through a problem-solving process exploring both the benefits and disadvantages of various Green and Blue Infrastructure heat stress mitigation options. For example, although most ecologists agree that planting trees in public places is generally a good thing, not everyone likes trees – have you ever parked your car under a sycamore or lime in summer? For facilities managers, leaf clearance, ideally before anyone slips on them, is an annual headache and a real financial cost. The benefits of water features, particularly when they are multi-purpose with flood or water retention functions, can be easier to justify although there are still health and safety implications. Working through the advantages and disadvantages of different options with multiple stakeholders has been very useful and will ensure that the decision support tool provides genuinely useful information for the users. Training materials will also be produced, aimed at promoting the full range of benefits (and disbenefits) to planners, architects and maybe ecologists and environmental managers as well.

If you are involved in any Green and Blue Infrastructure projects and would like to contribute information on installation and/or maintenance costs, please do let us know. The author (or her postgraduate students) would be happy to come along – on a suitably hot day – to measure the effectiveness in terms of heat stress mitigation.

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