Trees, people and cities

Despite the fact that trees have so many positive and aesthetic attributes for urban planners, they are constantly under threat. **Duncan Goodwin** outlines the major threats and challenges.

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In design terms, trees have always been one of the urban planner's most useful tools. Trees can improve urban spaces by bringing an aesthetic value to the urban landscape, helping to soften hard surfaces. They help to provide a setting for buildings and help delineate spaces and inform a hierarchy of use. They provide separation by introducing visual and physical barriers between spaces of differing use. They can aid circulation and guide movement, helping to inform direction and destination. They can be used to deflect the eye, concentrate the view and provide a sense of arrival. They will often bring a sense of calm to a setting. They introduce shape and form, increasing the visual diversity of the landscape. They can also introduce some quite spectacular colour displays during otherwise dull times of the year. But despite all the aesthetic qualities they bring to the landscape, urban trees are under threat as never before.

A review of London's street trees by the London Assembly Environment Committee produced a report in 2007, *Chainsaw Massacre*, which highlighted a trend in the reduction of street trees in London.[1] Despite claims that urban greening has increased, more large trees are being cut down than are being replaced. These findings were echoed by *Trees in Towns II*, a report commissioned by the Department of Communities and Local Government in 2008. This looked at urban areas across the country and found that what is happening in London appears to be happening in other urban conurbations throughout the UK.[2]

From this and a review of other urban tree research, we can make the following observations with regard to the interactions of trees, people and the built environment.

- ***Urban places can be brutal and tree-hostile*** Urban trees are surrounded by buildings, often planted within a sea of impervious surfaces and subjected to reflected and radiated heat, wind funnel and shade from sun and rain. The presence of underground utilities and other services lead to restricted available rooting volumes.

It is not uncommon for trees in built-up areas to be perceived as a nuisance. They are sometimes accused of casting shade when in leaf, blocking drains and gutters and creating messy, slippery surfaces by dropping leaves or fruit. Footway heave and paving deflection can be real issues for people with mobility problems and the partially sighted. Furthermore, we live in an increasingly litigious society where local authorities are constantly under threat of lawsuits against trip hazards.

A recent urban trend is the use of trees in the training of fighting dogs. It is not unusual

Photos Duncan Goodwin

Trees can be used to create a sense of direction and destination.

1 London Assembly Environment Committee (2007). *Chainsaw Massacre: A review of London's street trees.*
2 Department of Communities and Local Government (2008). *Trees in Towns II: A new survey of urban trees in England and their condition and management*

to see tree stems and branches stripped of their bark where they have been used to sharpen teeth and strengthen a dog's jaws. Perversely, the RSPCA reports that there are more pit bull-type dogs in the UK now than when they were outlawed by the Dangerous Dogs Act in 1991.[3]

● ***Insurance claims*** Foundation movement often manifests itself by signs of cracking during periods of dry weather in structures built on susceptible soils. Trees are often implicated as the cause of structural damage to property, especially on the shrinkable clay soils of London and the south-east. However, outside these areas the risk is fairly low and even within London, the London Assembly recorded that only 5% of the trees felled between 2002 and 2007 were as a result of subsidence claims.[4]

The Mayor's *London Tree and Woodland Framework* suggests that the perceived threat of subsidence is far greater than the actual risk and estimates that less than 1% of the total tree population has actually caused damage to property.[5] Where there is clear and substantial evidence that trees are involved in subsidence cases, local authorities usually remove the trees concerned, or grant permission for removal, otherwise they risk having to pay the costs. Developers will often exploit this, as will the media in search of a story.

National House-Building Council (NHBC) provides guidance for suitable foundations close to trees. It states that "foundations shall be capable of accommodating the effects of trees and hedgerows on shrinkable soils without excessive movement".[6]

Creative thinking

Conventional landscape paradigms in our urban environment, and tree planting in particular, are being challenged as never before. As urban planning and landscape practitioners we need to look beyond the aesthetic and think much more creatively. Our cities need to be multi-functional, they need to be able to adapt to expected increases in population and the uncertain outcomes of predicted climate change. To help inform our design objectives, there is a wealth of research out there that supports the benefits of trees.

Trees provide settings for buildings.

Trees inform movement and provide a sense of arrival.

Social and Health Benefits

Frances Kuo and William Sullivan, from University of Illinois at Urbana-Champaign, found that, contrary to popular belief and many academic studies, the presence of vegetation in urban areas may actually reduce the incidence of crime.[7] They suggest that the connection between trees and social eco-system health is an extension of Oscar Newman's defensible space theory.[8]

The presence of trees can be a decisive factor in the extent to which residents take ownership of their local area, encouraging people out of their homes and into public open space, providing opportunities for informal social contact among neighbours. This helps to create a system of informal surveillance that in turn can discourage potential perpetrators whilst at the same time mitigating some of the psychological precursors to violence.

Research conducted by Roger Ulrich of Texas A&M University has shown that hospital patients who have a view of green space and trees recover faster and require less post-operative pain medication.[9] Views of nature rapidly reduce the physiological stress response. Further studies by Ulrich and many others show that heart rate, blood pressure and other body function

3 RSPCA (2008). *The welfare state: measuring animal welfare in the UK*
4 London Assembly Environment Committee (2007). *Chainsaw massacre: A review of London's street trees.*
5 GLA (2005). *Connecting Londoners with Trees and Woodlands – A Tree and Woodland Framework for London, Greater London Authority*.
6 NHBC (2007). *NHBC Standards Part 4 – Foundations*, National House Building Council.
7 Kuo, F E and Sullivan, W C (2001). Environment and Crime in the Inner City: Does Vegetation reduce Crime? *Environment and Behavior*, 33 (3), 343-367.
8 Newman, O (1972). *Defensible space: Crime prevention through urban planning*. New York: Macmillan.
9 Ulrich, R S (1984). View Through A Window May Influence Recovery From Surgery. *Science*. 224, 420-421.

Well-placed trees help to create and define social spaces.

measurements return to normal levels more quickly when people view nature after a stressful experience.[10]

When compared to the extraordinary costs involved with health provision, incorporation of gardens in hospitals and other healthcare facilities would appear to offer an opportunity to reduce the costs of care. Poor mental health costs the UK economy an estimated £26.1billion per year. The Faculty of Public Health suggests that access to safe public green space may be as effective as prescription drugs in treating some mental health illnesses.[11]

> "Trees have also been shown to absorb pollutant gases such as ozone, nitrogen oxides, sulphur dioxide, carbon monoxide and carbon dioxide"

Urban heat island effect

Today trees, as part of green infrastructure, are being recognised more and more as an important strategic asset. Some 90% of UK residents live in an urban environment, as does more than half the world's population. Cities are hot, noisy places with poor air quality and are prone to flash flooding during rainstorms. They consume vast quantities of energy to cool in summer and heat in winter. The heat island effect typically raises city temps by approximately 4°C above surrounding rural areas. This will be made worse by climate change.

The urban heat island effect is mainly caused by energy from the sun being absorbed by buildings and hard surfaces where it is stored as heat. Most urban surfaces are dark (low albido) and reflect often less than 10% of this solar energy. This can be even lower in high-rise cities where the energy is reflected down into so-called urban canyons. At night the stored heat is slowly released from the buildings and other hard infrastructure keeping the air temperature high. Pollution, which tends to collect in urban canyons, can exacerbate the problem by helping to trap long-wave radiation and preventing it dissipating. Conversely, rural vegetation typically reflects approximately 25% of the incoming radiation from the sun with much of the remainder being used to drive evapo-transpiration, an important component of the hydrologic cycle. Less energy therefore remains to heat the air by convection and the ground by conduction. This is nothing new.

Trees have been used for centuries to reduce high summer temperatures by providing shade and by absorbing solar energy to evaporate water and so cool the air. Dr Roland Ennos and his team from University of Manchester have calculated that by increasing the tree cover of Manchester by 10% the maximum surface temperature should reduce by 4°C, effectively climate-proofing the city to 2080.

Air quality

Urban particulates can contain toxic compounds of heavy metals, traffic exhaust emissions, car tyre materials and brake dust. Air-borne particulates with a size in the order of 10micrometres and less (PM10) are thought to be small enough to enter the human lung where they can settle and cause a variety of health problems. Trees can intercept and slow air-borne particulate materials, causing them to fix to leaves and branches. It has been claimed that a roadside sugar maple of 300mm stem diameter can remove 60mg cadmium, 140mg chromium, 820mg nickel and 5,200mg lead from the air in one growing season.[12]

When it rains, these particulates can be washed onto the ground where they can be bound within the soil matrix. Trees have also been shown to absorb pollutant gases such as ozone, nitrogen oxides, sulphur dioxide, carbon monoxide and carbon dioxide.[13]

Although improvements in air quality have been shown to reduce the severity of asthma, Nick Hewitt and his researchers at Lancaster University found that some trees produce volatile organic compounds (VOCs) which, if they combine with some man-made oxides of nitrogen (NOx), can lead to an increase in ozone, particulates and other pollutants. Wind-pollinated species such as willows, poplars and oaks can potentially reduce air quality during hot weather, if planted in sufficient numbers. However, they calculated that doubling the number of trees in the West Midlands could reduce the concentration of small particulate pollution by 25% which, in turn, could lead to a reduction of 140 deaths each year, caused by airborne particles.[14]

Opportunities for community orchards

Until fairly recently almost every suburban garden had its own fruit trees and orchards were once widespread throughout the country. Indeed British apple varieties originate from places all over the country. An ever-increasing demand on land for building and cheap food from around the world has been partly responsible for the demise of the fruit tree. Orchards in villages and on the edges of towns are particularly vulnerable as prime targets for development. Common Ground first started work on creating and conserving local orchards in 1992 and produced the *Community Orchards Handbook* in 2008. This manual, written by

10 Ulrich, R S et al (1991). Stress Recovery During Exposure to Natural and Urban Environments. *Journal of Environmental Psychology*, 11, 201-230.
11 Faculty of Public Health (2010). *The Great Outdoors: How our Natural Health Service uses Green Space to Improve Wellbeing*.
12 Coder K D (1996). *Identified Benefits of Community Trees and Forests*, University of Georgia Co-operative Extension Service – Forest Resources Publication FOR96-39.
13 Nowak, D et al (2006). Air pollution removal by urban trees and shrubs in the United States *Urban Forestry & Urban Greening* 4, 115-123.
14 Hewitt, N et al (undated) *Trees and Sustainable Urban Air Quality: Using Trees to Improve Air Quality in Cities*, Research summary from Lancaster University at http://www.es.lancs.ac.uk/people/cnh/docs/UrbanTrees.htm

Angela King and Sue Clifford, provides a 'lessons-learned history' of the philosophy and practicalities of creating orchards for and by the local community.[15] Some existing community orchards have been incredibly successful, by providing community cohesion through celebration, horticultural experience and fruit production.

Enhanced property prices

The links between property values and consumer behaviour to proximity of green space and street trees have been talked about in American research literature for many years. Property value increases of 7-15% are typical. In 2002, the office of the Deputy Prime Minister commissioned a study to review the available literature of the time that considered the economic value of different land types.[16] This report established a relationship between property values and proximity of trees and urban green space. The following year, the GLA commissioned its own report that confirmed this link in London.[17]

It found that within a typical London Ward, a 1% increase in green space could lead to a 0.3-0.5% increase in local property prices. CABE took these and other international studies to develop their own in-depth, case study approach.[18]

Their report suggested property value premiums, for properties close to urban parks, of 3-34%, with typical value lifts being in the region of 5-7% (the highest value of 34%, for Mowbray Park in Sunderland, is also thought to be due to other factors such as proximity to the city centre). As an example, the valuation of properties overlooking the restored Queen Square in Bristol was found to be 16% higher than comparable properties elsewhere.

> "Britain has one of the highest populations of veteran trees in Europe"

Cultural heritage

Trees are a significant part of the historic, cultural and ecological heritage of this country and as such help to inform local identity and the particularities of place. Veteran trees especially have been treasured by many generations; they provide a direct, historical link back to a previous age. Some are likely descendants of the natural wildwood that covered Britain after the last ice age. They contain a record of past climate changes and management methods. They may be an important gene pool for modern breeding and can provide an enormous biological resource for other species. As a consequence, or maybe because of this, Britain has one of the highest populations of veteran trees in Europe. The Veterans Trees Initiative that was launched in 1996 aims to promote the value and importance of veteran trees and conserve them wherever possible.

Source of fuel

Wood is becoming an increasingly attractive source of energy along with other forms of biomass. Beddington Zero Energy Development (BedZED) is reported as being both the first large-scale and the largest mixed-use, sustainable community in the UK. Peabody Trust led the project in partnership with the designer, Bill Dunster Architects and environmental consultants, BioRegional. It was completed and occupied in 2002. An important part of Bedzed's zero carbon strategy was the use of waste wood as a fuel for the Combined Heat and Power (CHP) boiler. The 1,100tonnes of wood chip required each year would be met by the tree surgery arisings from Croydon's green waste facility, The Croydon Tree Station.[19]

The Tree Station has the capacity to produce 6,000tonnes of fuel and the availability of locally sourced wood chip has resulted in other developments in the Croydon area opting for carbon neutral wood chip heating over more conventional fossil fuel sources.[20]

As a substitute for fossil fuels, UK wood fuel has the potential to save 7.3Mega tonnes of carbon dioxide ($MtCO_2$) per year over the next five years. If a further 1million ha of agricultural land was converted to energy woodland management, this could be increased to 14.6$MtCO_2$ per year over the next decade.[21]

Mitigation against flooding

Europe has seen its fair share of major floods in recent years and this is raising fears that extreme flood events may be increasing due to climate change. To make matters worse, the built environment is constantly expanding, increasing the area of

Utility companies require access at all times.

15 King, A and Clifford, S (2008). *Community Orchards Handbook*, Common Ground, Shaftesbury, Dorset.
16 ODPM/CLG (2002). *Valuing the External Benefits of Undeveloped Land: A Review of the Economic Literature*. Retrieved 19 August 2011, from http://www.communities.gov.uk/archived/publications/planningandbuilding/valuingexternal
17 GLA (2003). *Valuing Greenness: Green spaces, house prices and Londoners' priorities*, Greater London Authority.
18 CABE Space (2005). *Does Money Grow on Trees?*, Commission for Architecture and the Built Environment
19 BioRegional Development Group (2006) *Wood Chip Production from Tree Surgery Arisings in Croydon*.
20 4ecotips (2006). Recycling waste wood into green fuel. Retrieved 19 August 2011, from http://www.4ecotips.com/eco/article_show.php?aid=670&id=279
21 National Assessment of UK Forestry and Climate Change Steering Group (2009) *Combating Climate Change: A Role for UK Forests*. Edinburgh: HMSO.

Trees can be perceived as causing problems.

hard, impervious surfaces and so decreasing the area available for water infiltration. Increased water run-off increases erosion and loading on existing surface water systems that in turn, can cause flooding. It is well known that trees and other vegetation can be shown to intercept, slow and absorb water in forests and woodland ecosytems.[22] Researchers at Ghent University in Belgium found that a single beech tree in an oak-beech forest, was found to intercept an average of 21% of the precipitation over a two-year period.[23]

As rainfall interception is mainly due to foliation, it is reasonable to assume that these results should be consistent with urban tree studies. Indeed a rainfall interception study in Oakland, California, found that 25% of the gross precipitation could be intercepted by deciduous urban trees. This is supported by other studies where similar interception rates for a Callery pear and a cork oak in Davis, California, were found to average 15% and 27% respectively. Research at the University of Manchester estimates that increasing the tree cover within the residential areas of Greater Manchester by 10% would reduce local surface water run-off by 5.7%.[24]

Although green space alone cannot be relied upon to moderate the expected volumes of surface water run-off under predicted climate change, it could prove useful, especially if integrated with other Sustainable Drainage System (SuDS) measures.

Carbon sequestration

Trees are massive carbon sinks so can help combat climate change and global warming. The Forestry Commission has calculated that a maximum carbon stock of approximately 250tonnes C/ha can be stored in 'old growth' woodland in the UK. The total national carbon stock in above ground woody biomass, at approx 150MtC, equates to the 150MtC (as carbon dioxide) from UK fossil fuel emissions in a single year.[25]

However, the UK woodlands are relatively young and actively growing so the net uptake of C in UK woodland, at approx 4MtC per year, is significant in comparison to national emissions reductions commitments made under the Kyoto Protocol. As they mature, this carbon sequestration will diminish.

A 2011 UK study that considers the biological carbon storage within the city of Leicester, estimates that over 230KtC is stored in above ground vegetation. Of this, 97.3% (225KtC) consists of carbon stored in trees.[26]

Due to lower tree density alone, urban forests are likely to store and sequester less carbon than commercial forests per unit area. However, when considering per unit tree cover, urban forests may out perform their commercial cousins. This is due to a higher proportion of larger trees in urban environments and faster growth rates due to more open growing conditions. In fact, individual urban trees may contain four times more carbon than individual trees growing in forest stands.[27]

Conclusions

So what needs to happen? How can these issues be addressed? *Trees for Towns II* highlights the importance of local authorities having a comprehensive, planned and integrated tree strategy as part of their Local Development Framework.[28]

Such a tree or green infrastructure strategy would need to be formally adopted and would be a material consideration in the determination of planning applications. Any such strategy requires information, education and consultation prior to implementation.

Information

iTree, a software suite, developed by the United States Forest Service, quantifies economic, environmental and social qualities of urban trees and calculates the net green infrastructure benefit in £ or $ - a value and a currency that politicians understand.

In New York City it was found that every $1 invested in urban trees and tree care, yields $5 in energy savings, air quality improvements, storm water mitigation and real estate enhancement. This has been instrumental in ensuring Mayor Michael Bloomberg's backing of the MillionTreesNYC initiative that commits to planting and caring for an additional one million trees throughout the five boroughs of New York City. The project was launched in 2007 with nearly $400 million being made available to the NY Parks Department over the following ten years to provide 600,000 public trees. The remainder is to come from other public and private partners.[29]

Forum for discussion

Trees and Design Action Group (TDAG), a Capita Lovejoy (now Capita Symonds) initiative, brings together practitioners from several disciplines including landscape architects, urban planners, tree managers and local authority tree officers, with insurance brokers, developers and structural and civil engineers. By creating an open and honest forum for discussion this has produced valuable guidance to safeguard the retention of trees.

A co-ordinated, multi-disciplinary approach is necessary to ensure urban green space fully exploits the interaction between trees, people and urban environments. Landscape architects, as environmental and land-planning design specialists, are uniquely positioned to deliver multi-functional green infrastructure projects which provide both actual and perceived value for money for the benefit of clients, residents, local authorities and the greater community.❑

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23 Staelens, J et al (2006). *Rainfall partitioning into throughfall, stemflow, and interception within a single beech (Fagus sylvatica L.)canopy: influence of foliation, rain event characteristics, and meteorology* in Hydrological Processes Volume 22, Issue 1, pages 33–45.
24 Gill, S E; Handley, J F; Ennos, A R and Pauleit, S (2007). Adapting Cities for Climate Change: The Role of the Green Infrastructure. *Built Environment* 33(1), 115-133 (19).
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