environmental SCIENTIST

May/June 2008

THE URBAN ENVIRONMENT: 2

Journal of the Institution of Environmental Sciences

environmental
SCIENTIST

Journal of
the Institution of
Environmental Sciences

ISSN: 0966 8411
Vol 17 No 2
Established 1971

The Environmental Scientist provides a forum for members' contributions, views, interests, activities and news, as well as topical feature articles. Articles should be submitted to the Editor, Environmental Scientist, Suite 7, 38 Ebury Street, London SW1W 0LU or emailed to *enquiries@ies-uk.org.uk*.

Views expressed in the journal are those of the authors and do not necessarily reflect IES views or policy.

Guest Editors: Sir John Lawton, Harry Joll & Adam Donnan

Published by The Institution of Environmental Sciences, Suite 7, 38 Ebury Street, London SW1W 0LU.
Tel: 020 7730 5516
Fax: 020 7730 5519
Email: *enquiries@ies-uk.org.uk*
Web site: *www.ies-uk.org.uk*

Design and origination by Davies Communications, London NW5 1LX.
Tel: 020 7482 8844

Cover illustration: Mona Vaghefian

Printed by Uniprint Ltd, London SW12 8SG, using recycled paper and inks based on renewable raw materials that contain no mineral oil.

THE URBAN ENVIRONMENT AND THE ROYAL

SIR JOHN LAWTON CBE FRS, Chairman of the Royal Commission on Environmental Pollution, intoduces the second part of our look at the urban environment

Following on from the January/February 2008 edition of this journal, it gives me great pleasure to introduce this second series of articles on the urban environment. They deal with subjects from the built, office environment to environmental justice in urban areas, from predicting the behaviour of pollutants in the urban environment to 'hidden rivers' – those unfortunate watercourses entombed in concrete below many of our cities and towns.

The *Environmental Scientist's* focus on the theme of the urban environment is timed to coincide with the Royal Commission on Environmental Pollution's recent report on the subject. The RCEP was established in 1970, to advise the Queen and the various structures of government on environmental issues. *The Urban Environment*, its 26th report, examined three areas of concern for the UK's urban environment: human health and well-being, urban green space, and the built environment.

'Hidden rivers' encapsulate in one small but important way some of the environmental problems that confront us in urban areas, and Mark Everard writes eloquently and with passion about the problem, and possible solutions. Opening these rivers to the daylight, restoring the riparian habitat and associated floodplains, and creating ribbons of green space along the liberated river can have huge social, human health, flood-mitigation and biodiversity benefits, as well as providing a focus for urban regeneration and renewal. We cannot do it everywhere, but we can and should do it more often. When the RCEP visited Glasgow as part of our research for the urban report, we saw some exciting, indeed visionary attempts to restore urban rivers in that city, reducing the risks of flooding and sewage leaks in the process. A more conventional engineering solution would have been to put in bigger pipes. Urban areas deserve more imagination than that.

Urban environments are hugely complex socio-economic, physical and biological systems, and our natural tendency is to break them up into manageable components: buildings, green space, drainage systems, transport, air pollution and so on. This is fine as far as it goes, but as Noel Nelson pointed out in his introduction to the previous edition (and which *The Urban Environment* explores in some depth), urban environments are a classic 'wicked problem', characterised by highly connected, often unexpected links, replete with the 'law of unintended consequences'. Simple-minded compartmentalisation of issues and problems, without recognising the bigger picture and the complexity, can sometimes lead to unexpected, undesirable results. Increasing car ownership, for example, is at a personal level seen as a 'good thing'. But in urban environments it directly contributes to rising air pollution and adverse impacts on human health. It also drives the growth of large, dispersed retail centres, the closure of local shops, and the creation of 'food deserts' for low-income families without cars. These are two highly undesirable social consequences. Indeed, often the poorest and most disadvantaged

COMMISSION ON ENVIRONMENTAL POLLUTION

> We will not get healthier, more socially just, and more environmentally friendly urban environments without a radical shift in the way we manage and govern them.
>
> *– Sir John Lawton*

members of society end up living in areas devoid of local shops and with the worst air quality.

The article in this present issue by Gordon Mitchell provides a thoughtful analysis of exactly this kind of problem, asking 'will Britain's cities grow in an environmentally just way?' Social justice is not something that the RCEP's Urban Report considered (another characteristic of a 'wicked problem' is that there are no clear boundaries to limit the scope of the issues to be evaluated), but it is clearly highly desirable to do so.

One obvious way to improve the lot of those unfortunate citizens exposed to poor air quality is to take appropriate local management steps to mitigate or even eliminate the problem. But how best to do this? Carol Pettit provides a short summary of PUrE (Pollutants in the Urban Environment), a decision-support framework to enable sustainable management of all kinds or urban pollution, not just air pollution, targeted at policy-makers, local authorities, industry, researchers and NGOs. Wicked problems need all the weapons at our disposal to tackle them, and Harry Joll's article brings together some fascinating candidates for such an arsenal. The range of initiatives discussed, most of them led by pioneering design, concentrate on both individual streets and neighbourhoods to whole towns.

As one of several examples of social injustice, Gorgon Mitchell points out that children living in the most deprived areas are five times more likely to be killed in a road accident than children in more affluent areas. Road traffic deaths are terrible, and as a society we have quite rightly put great efforts into trying to reduce them. But, as *The Urban Environment* points out, air pollution in Britain causes about 24,000 premature deaths each year, whilst traffic accidents kill 3,300 adults and children. And yet we continue to allow urban air quality to decline.

There is therefore a nice irony in the paper by Stellios Plainiotis in this edition, writing about a state-of-the-art environmentally friendly office building (Amazon Court) in Prague. As a piece of the built, urban environment, it is indeed impressively green, and yet its provision of parking for over 250 cars goes unquestioned. Wicked problems require unintended consequences to be thoroughly evaluated.

What Plainiotis's article does show is that 'more resource efficient and sustainable offices make financial sense to occupiers, investors and developers alike.' Nevertheless, depressingly few such offices are being built in Britain. On the related topic of heritage and its position in the urban environment, Dr Carly Brooks and Diana Beattie stress the need to protect the historical and community value enshrined in many of our buildings. The article also poses interesting questions about the environmental impact of new construction versus regenerating existing buildings.

The Commission was intrigued by this paradox. We already have the technologies and know-how across the board (buildings, resource use, CO_2 emissions, waste recycling, water management, etc) to deliver infinitely more sustainable urban environments. There are demonstration projects all over the place, but precious little mainstream development to follow their example. We examined this paradox in detail and concluded in the report that a whole web of constraints, not lack of know-how, inhibits the application of highly desirable, existing technologies. These include the wrong or weak institutions and governance systems, the difficulties of changing existing infra-structure, poor or perverse incentives for people to change their behaviour (including fiscal policy), and lack of information. One solution to cut through the web would be a 'contract' between regional and local government setting out high-level goals for all local authorities to achieve (e.g. targets for reducing urban CO_2 emissions), but then devolving much more power, priority setting and decision-making to local levels, through elected representative, citizens' groups, NGOs, local business and so on. The problems of the urban environment in Birmingham are not the same as those in Bangor or Belfast, and they are not even the same in different parts of these cities. The framework for doing this in England at least already exists through mechanisms like Local Area Agreements.

As Gordon Mitchell points out: 'the planning system should ensure that the public is actively involved in the development appraisal process.' We will not get healthier, more socially just, and more environmentally friendly urban environments without a radical shift in the way we manage and govern them.

REDISCOVERING THE URBAN JUNGLE

DR MARK EVERARD muses on the sad fate of many urban waterways and considers how they can be revived

There is a small river, or rather the strangled remains of what used to be a small river, in a market town close to where I live. It makes me sad every time I see it. Most locals are unaware of its existence, squeezed and cryptic as it is between the brick walls of nearly adjacent buildings and largely blocked off from view from the pavement. The waterway is not huge; indeed, it is normally dry for much of the year. It is undeniably unsightly, scrunched between the windowless side walls of buildings and strewn with drink cans and plastic bags. Its habitat and wildlife can hardly be said to be diverse. A relatively recent 'improvement' to this piece of sad urban river has been the installation of metal grids on top of the bridge to keep a largely unaware public safe from risks of drowning or disease. Its imprisonment is almost complete.

And yes, this small river is ugly, hostile to wildlife, a potential source of diseases borne by rats, rusty cans, dirty water and other factors, and a drowning hazard as the water occasionally surges in flash floods constrained by close walls before funnelling into a narrow culvert. But what makes me sad above all else is that it is we who have made the river so.

Strangled flows

The Industrial Revolution paradigm which has propelled developed society through the last two and more centuries, the influence of which still permeates so many modern assumptions, is seeded upon a model of progress exemplified by brick, concrete, tarmac and an envisaged 'fight against nature'. The little river in my local market town is but one largely forgotten victim of 'progress' throughout the county, nation and globe.

Across London, and indeed many major cities of the developed world, a network of almost forgotten rivers flows under people's feet. The River Fleet once gave Fleet Street its name, but now only trickles unseen beneath it. To this legacy of lost rivers of London we can add the Walbrook, Neckinger, Tyburn, Effra, Westbourne, Hackney Brook, Falconbrook and Peck; an incomplete list of formerly bubbling brooks that Izaac Walton may have known as rich in fishes during his seventeenth century heyday but which now fail even to see the light of day. Some may be remembered only by local street and place names. Countless more have been expunged entirely from memory and existence by urban sprawl.

Paradise lost

Altruistic yearning for a bygone age is not the only reason for mourning the loss of the once living and iconic watercourses that formerly weaved through our burgeoning built environment. There is also a palpable sense that humanity has set itself on a course of mutually destructive conflict with wildlife for, along with the demise of urban rivers, we have also lost the many benefits that they once conferred upon local people.

In their pre-industrial state, these watercourses, like rivers of every scale and geographic place, performed diverse ecosystem functions from which a wide range of beneficial 'goods' and 'services' flowed to humanity. Many of these urban watercourses would have been, among other things, sources of water for local domestic use; supplies serving industrial purposes including the powering of mills; places for watering horses and stock and irrigating low-lying tilled land. Also, aside from benefiting farmed animals and crops, urban waterways provided food such as fish and wildfowl, as well as a place to renewably harvest rushes for thatching, timber, sand and shingle for construction, and other beneficial 'goods' besides.

Added to this, their floodplains, albeit progressively constrained, and their natural channel capacity and connectivity with groundwater, would have assisted with the absorption of floodwater pulses. As we have seen, for example with the Rivers Peck (Peckham) and Fleet (Fleet Street), the now lost rivers also used to be defining characteristics of the landscape and the pattern of human settlement, as rivers have been across the world. The Westbourne River was in centuries past known by different names along its length, ranging from the Cye Bourne (Kilburn), Bayards Watering Place (Bayswater) and the Serpentine River (the Serpentine in Hyde Park). It once provided fresh piped water to the city of London, before being polluted and then encased in an iron conduit still visible above the platform at Sloane Square tube station. A similar saga of forgotten rivers is repeated across the globe, from Vietnam to the USA, and everywhere in between where concrete is poured in the name of progress. As this myopic and mechanistic model of advancement has taken shape, it has digested the very resources that made it possible in the first place.

As industrial-age cities have mushroomed, mounting metabolic demands for energy, water, food and other resources have created greater burdens upon ever-widening hinterlands, as their sprawl has all too often strangled the very natural resources around which they formed. Where once urban rivers and riparian habitat provided

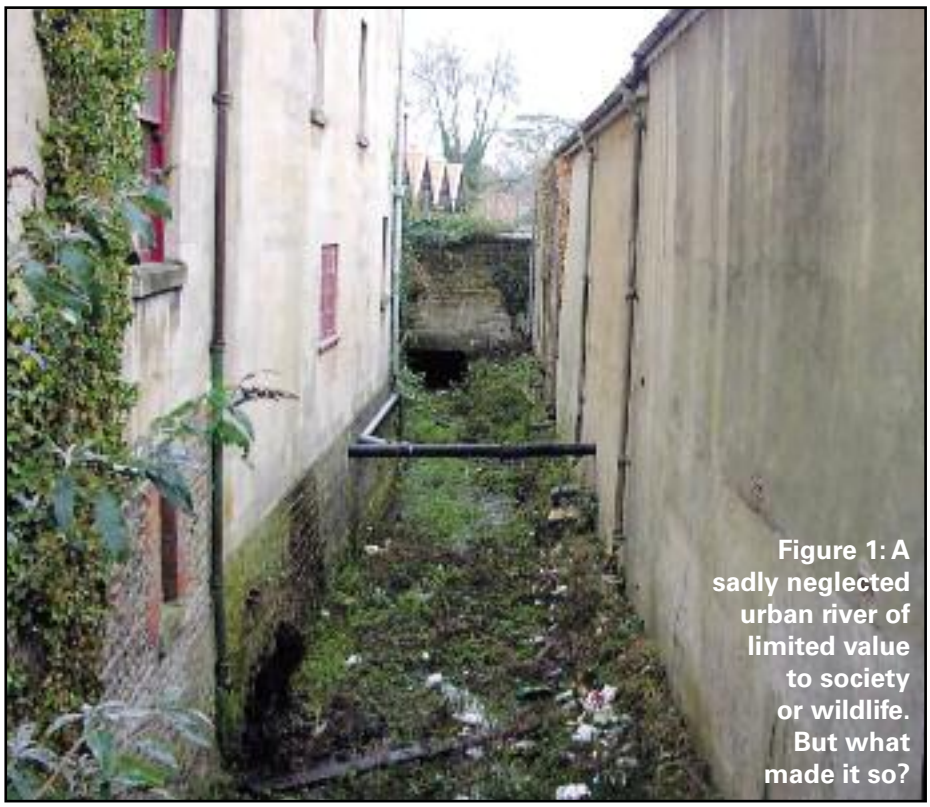


Figure 1: A sadly neglected urban river of limited value to society or wildlife. But what made it so?

valuable and valued resources supporting the needs of urban lifestyles – physically, economically, culturally and spiritually – they have become progressively poisoned, constrained or even covered over entirely, denuded of habitat, and otherwise rendered ugly and hostile to both wildlife and human health. It is worth remembering that this resource-destructive tale is the legacy of a model of progress that has driven human development for centuries, and continues to do so, through its still largely unreconstructed entrenchment in governance and economic systems. So the tendrils of cities spread ever wider, tapping water from increasingly remote surface and underground sources, magnetising food and construction resources from surrounding tracts of countryside and along international trade routes, and filling adjacent land, water and air with waste that the urban heartland can no longer absorb. As they spread outwards like an invasive bacterial colony, our cities become ever hungrier: the urban sprawl absorbs and degrades resources and productive ecosystems in its path.

The legacy of urbanisation

This is, of course, just one 'story' of urban expansion, ignorant and exploitative of the natural resources that ultimately underpin all human needs for basic sustenance, wealth creation and quality of life. It is self-evidently an apocalyptic, self-extinguishing scenario. The irony is that, unlike many science fiction interpretations of this archetypal 'story', we need neither robots nor invading aliens to blight our future. Our pattern of growth is doing that all on its own.

Our contemporary cities are, of course, a monument to a great deal of human progress, including the unprecedented health, wealth and material quality of life enjoyed today by many people. However, our 'lost' urban rivers are but one reminder that this is a model of progress which destroys the resources upon which long-term wellbeing depends. Already, we are becoming aware that the unsustainable principles upon which our western society and its cities are founded have yielded us only a temporary enhancement of opportunity by 'mining' core resources, a habit that will surely starve the potential of people to meet their needs and aspirations in the future.

If we want more reminders of the dangers of self-limiting resource over-exploitation, we have the monuments and cities left behind by human history. Take England's various 'lost villages' as an example. Before the Black Death in medieval England, many rural areas were already becoming malnourished by inadequate rotational land use practices that failed to renew the fertility of their soils, rendering their inhabitants even more susceptible to the advancing pandemic. The iconic statues of Easter Island are a legacy of an extinct culture which outstripped its own food reserves, crashing as monumentally as the landmarks it left behind. These are gross examples of collapsing societies ultimately strangled by degradation of the basic resources upon which they depended; the pattern is one we can see in the population curves of laboratory organisms cultured in sealed vessels and forewarned by Thomas Malthus. There are countless other more chronic instances. Significantly, they include the 'water wars' of the Middle East and the consensus that water will be one of the key limiting factors to global human development during this century; problems greatly exacerbated by climate change.

Many of our cities are already built upon vulnerable, water-hungry lifestyles dependent upon transfers from remote catchments. Perhaps most dramatic is the case of Johannesburg, which receives most of its water transferred not only from adjacent drainage basins but largely derived from the wet uplands of Lesotho, a different country altogether. Furthermore, despite the use of gravity feed in many of these transfers, there is also a significant dependence upon large quantities of energy for pumping, interna-

tional goodwill to sustain these flows, and limitation of access to water for those towards whom the rivers would naturally have drained, demonstrating the vulnerability of water demands that have wholly outstripped local carrying capacity. Finally, and most infamously, modern urban lifestyles right across the globe are almost completely dependent upon a petrochemical resource that we now know to be reaching a crisis point, namely the balance between spiralling global demand and peaking supply.

In short, urban lifestyles have developed on a model of resource consumption that assumes unlimited access to fresh supplies beyond the city bounds, and which therefore ignore and often poison or expunge the very resources that once lay within the city's own confines. Today, with 6.2 billion people around the globe vying for dwindling natural resources and widespread degradation of the ecosystems that regenerate them, this model demonstrably does not work, and will surely limit the capacity for future human development.

It need not be that way…

An urban renaissance

Of course, nature is utterly irrepressible. Dandelions, buddleia, nettles and rank grasses thrive in the scrubland, neglected corners and cracks between paving slabs in our towns and cities. Urban foxes are hardly an endangered species, nor the pigeons, sparrows and other opportunists that find niches in the built environment wherein rats and cockroaches also excel. However, we do tend to live today somewhat opposed to the natural range of biodiversity that our sprawl has displaced, in both urban settings and in intensive agricultural land. More importantly, we have also undervalued and thrown away the myriad benefits yielded by natural ecosystems.

The 'bottom line' is that people need nature. This sentiment goes way beyond the altruistic, extending deeply into our total dependence upon the purification processes by which water, air and soil are regenerated to support our basic needs in terms of physical wellbeing, wealth-creating activities and quality of life. As we degrade such resources closer to home, we rely on more remote ecosystems to produce them for us, transporting them into our cities at increasing cost, with rising energy input and polluting output, and competing for them with other growing cities. Better then to recognise, protect and, ideally, restore nature and its beneficial functions within the urban environment.

Proximity to nature has value not just in terms of cheaper, more secure access to resources, but also directly for our health, spiritual fulfilment and the value of property. There are many gratifying stories of how the waterside environment has served as a central element of an urban renaissance. British examples abound: the major investment in river-focused regeneration at Salford Quays on the Manchester Ship Canal; the Leeds waterfront on the River Aire; areas of Manchester focused on transformation of the 'Dark River Irwell'; Glasgow's waterfront with the rivers Clyde and Kelvin; in Kent along the River Medway; and in Northumberland fronting restored stretches of the Rivers Tyne and Wear.

Neither are these tales of recovered 'naturalness' in rivers, serving as a catalyst for urban pride, value and regeneration, restricted just to the UK nor to rivers already prominent in the landscape.

> The 'bottom line' is that people need nature. This sentiment goes way beyond the altruistic, extending deeply into our total dependence upon the purification processes by which water, air and soil are regenerated to support our basic needs

The story of London's 'lost' River Quaggy is inspiring, exhumed from a concrete grave and reinvigorated as a central element of urban regeneration through central Lewisham in south London. Local flooding had become a troublesome issue, but by the late 1980s it became apparent that increasing the concrete channelling on the largely buried Quaggy would be a less effective solution than restoring some floodplain area into which water could harmlessly overspill. This initiated a period of local dialogue, planning and activism from which Operation Kingfisher – a plan for a complete progressive river restoration of the Quaggy from Chinbrook Meadows to its confluence with the River Ravensbourne in Lewisham town centre – emerged, not only as a means to alleviate flooding, but also to regenerate the area. In 2002, work commenced at Chinbrook Meadows to remove 300 metres of concrete lining of the river channel. The effect was as dramatic as it was nearly instantaneous, the restored river burgeoning with plant and animal life and revitalising interest in the environment and the formerly underused public recreational space. The following year, a section of the river at Sutcliffe Park that used to run through a culvert was restored into meanders and wildlife-friendly habitat, and concrete channels at John Roan School playing fields were also removed to recreate a river of more 'natural' character. A range of habitats was engineered, including the river channel, adjacent still waters, wildflower meadows, reed

beds and a variety of native trees, with the whole able to flood freely with rising river levels. Further sections of river have been or are being restored, realising a range of environmental and social benefits, and credited with increasing the attractiveness and property value of the area. The Quaggy initiative has not so much restored the river as eliminated many of the negative pressures that had previously eliminated the social and economic benefits flowing from natural ecosystem functioning.

Application of the principles and practice of river-centred urban regeneration is being seen increasingly around the world. Just one specific example is the Cheong Gye Cheon river restoration in Seoul, the capital city of South Korea. When it was covered over by concrete in the 1930s, the Cheong Gye Cheon was perceived as a threat to the city, polluted and surrounded by slums which flooded frequently. By the 1960s, it had been covered by a highway and effectively lost completely to the community. However, various enlightened decisions were taken from the 1990s, resulting in the river and riparian habitat being progressively opened up and restored in a process of urban regeneration that has recovered historical and cultural value, provided floodwater protection for 1 in 200 events, and seen the return of numerous fish, birds and insect species. The Cheong Gye Cheon river has become a focus for urban regeneration in the city and also one of the country's major visitor attractions since its formal opening in 2005.

From Germany, Denmark and many other European countries, and across the US, South Africa, Australia and the Far East, there are many more instances of river restoration, including the disinterment of formerly 'lost' rivers, providing an invaluable focus for urban regeneration.

Rediscovering the place of nature

It is good to be in touch with nature and to enjoy more natural open spaces, but the real power of these many tales of nature-focused urban regeneration lies not in anything vague or altruistic but in tangible benefits provided to society by nature.

These benefits are many and of substantial economic worth. A recovering urban river can help avert flooding by the natural absorption of spates, and moist adjacent habitats can eke out flows through drier months as a useful additional resource. Green spaces and urban trees can make tangible differences to air quality, not to mention attractiveness and the 'liveability' of neighbourhoods that are directly reflected in enhancements to property values and a sense of local pride and place.

Just one example of the dramatic scale of ecological benefits to cities is provided in an economic study by the New York City Department of Parks and Recreation. It found that the 592,130 street trees in the city, excluding those in open spaces such as Central Park, produced a staggering $122 million in annual benefits. A sound investment, if ever there was one, when each dollar spent on trees returns $5.60 worth of quantifiable benefits in the form of cleaner air, noise reduction, flash flooding protection, shade, and emotional and physical wellbeing.

Despite all the benefits of modern, industrial life, we live today in an urban world significantly detached from the natural world. Of course, we pipe nature into our modern urban lives, be it water physically piped into our homes and offices with a return flow of foul water for reintegration into distant rivers and seas with more dispersive capacity than urban watercourses, or 'piped' images of nature on our TV sets, freight in food produced by the fertility of distant soils, and access to 'green' recreational spaces by car or public transport.

The challenge is to recognise that these technological means are ultimately little more than methods to reconnect us to the natural resources upon which our cities were founded and nurtured. It is these living resources, not the finances and technologies that attach us to them, that constitute the fundamental and irreplaceable assets upon which our wellbeing depends. Sustainability depends upon us making a future accommodation that protects rather than erodes the capacity of ecosystems, both distant and close to hand, to support our needs indefinitely. Critically, we have also to recognise the value of enabling local resources to once again sustain our needs.

"From Germany, Denmark and many other European countries, and across the US, South Africa, Australia and the Far East, there are instances of river restoration, including the disinterment of formerly 'lost' rivers"

We are witnessing a slow reawakening to the myriad benefits of the 'urban jungle', and our need to accommodate it in our evolving life styles. One day, let us hope, that small, sad river in my local market town will be restored to run freely again; pretty, clean and diverse, functioning closer to its natural state and thereby gracing the town with a diversity of associated 'ecosystem services' that are valued as an artery of resources and a focus for regeneration. Let us hope this becomes a reality not merely because the river deserves it, nor just because we feel it would be a nice thing to do, but because we have matured as a predominantly urban society to realise the wisdom and value of protecting the basic resources that make our lives healthy, wealthy and fulfilled.

WILL BRITAIN'S CITIES GROW IN AN ENVIRONMENTALLY JUST WAY?

GORDON MITCHELL of the School of Geography at Leeds University asks how we can ensure that new developments do not weigh most heavily on the most deprived

Britain is experiencing significant pressure for urban growth. A major surge of house building is planned to tackle a historically high demand for housing, a product of long term increases in rates of household formation and net immigration, and a legacy of reduced public sector house building since the 1960s. The current government target is for three million new homes in England by 2020 (CLG, 2007). To put this in context, there are approximately 21 million homes in England at present, so that target represents a substantial expansion, not just of housing, but also of associated development, including transport infrastructure and commercial, industrial and public sector activities.

Urban development on the scale of low carbon 'eco-towns' (which the government wishes to build as a part of its expansion plan) will inevitably have substantial environmental impact, not only at the local level, but on a wider scale: induced traffic, demand for resources and waste disposal facilities, for example. We don't yet have a clear picture of just where these additional environmental burdens will occur, or who will have to bear them. However, if past experience is anything to go by, then we might conclude that the most undesirable environmental impacts will accrue to the most deprived communities. This past experience is in part supplied by several national scale, small-area studies that reveal clear social inequalities in environmental risk and quality in the UK, in areas such as exposure to poor air quality and proximity to hazardous facilities like waste incinerators (see Box 1).

Demonstrating that one social group bears a disproportionate share of environmental impact is not equivalent, however, to demonstrating that the distribution is unfair, or that there is an 'environmental injustice'. One of the issues to consider is how the observed pattern arose. Which came first – the poor or socially excluded community, or the environmental hazard? However, further consideration of this question reveals more subtle and complex processes at work that can cause the poorest households to be geographically associated with areas of higher environmental risk, or low environmental quality. Even in the USA, where numerous class actions have been brought to the courts on the grounds of environmental injustice, cases of deliberate discrimination on the part of a corporation, planning or regulatory authority have rarely been proven, and it is likely there are other processes at work to create the uneven social distributions of environmental risk and pollution.

Box 1: Environmental inequality in England

2.5 million people live in wards where NO_2 exceeds the NAQS annual mean standard, of which more than half are in the most deprived wards in the country (Figure 1).

Integrated Pollution Control sites are more clustered in deprived areas, with greater numbers of emission sources presenting a greater pollution hazard and producing more offensive emissions than in less deprived areas (but no social gradient in the rigour of IPC inspection by regulators is evident).

Of those people resident close to a waste incinerator or other waste disposal facility, 52% are in the most deprived households, compared to 4% in the least deprived households.

Children living in the most deprived areas are five times more likely to be killed in a road accident than children in more affluent areas.

For every affluent household in a coastal flood risk area, there are eight households from the most deprived class. Deprived households are more vulnerable to flooding, as they often lack insurance to aid recovery.

Qualitative studies indicate that deprived communities are exposed to much greater levels of local incivilities (fly-tipping, neighbourhood noise, etc), and to cumulative impact, and enjoy poorer access to environmental goods and services.

Source: Lucas *et al* (2004), Walker *et al* (2003).

Whilst developers might consciously attempt to site so-called 'locally unwanted land uses' in minority communities – where they believe collective opposition to them will be weakest – other, more dynamic processes may be more instrumental in creating the observed environmental inequalities. Environmental inequality theories include those related to locational choice (e.g. firms locate where land and labour are cheapest); risk perception and acceptance (which is thought to vary amongst social groups); community transition (where, for example, affluent households are pushed away from an area by a development, and are replaced by lower income households which enjoy the benefits of the better housing that becomes available); and planning practice (which works to protect areas of high

environmental quality and usually sees social housing built in less desirable areas).

Few analyses have been conducted to examine the evolution of environmental inequalities. Still, it is clear that for those that consider process relevant, an understanding of the evolution of such inequality is important to its interpretation as 'fair' or otherwise. Others argue that how the pattern arose is largely irrelevant – the inequality must be judged for itself, or as it exists now. It is evident that a more fundamental consideration of what constitutes justice in this context is required – should an environmental inequality be judged as 'fair' so long as people get what they deserve, or according to what they need, or have a right to? Some of the earliest claims of environmental injustice in England arose when pressure groups such as Friends of the Earth claimed that poor air quality in our cities was due to 'rich' commuters, who lived in the suburbs but polluted the low income communities they drove through. This has been shown to be something of an oversimplification (Mitchell and Dorling, 2003), but serves as an example of injustice on the grounds of merit – one group (poor, non-car owning) were undeservedly bearing the degradation in air quality imposed by another group ('it's the rich that pollute but the poor that pay'). For some, this will still be considered an acceptable social distribution of environmental impact. On the other hand, if publicly agreed air quality standards are breached, then the distribution could be considered unjust from a human rights perspective, as everyone has an equal right to protection offered by the environmental regulation. In England, we know that people resident in areas where air quality is in breach of publicly agreed standards, designed to protect health, are predominant amongst the most deprived in the country (Figure 1). Many would consider this unjust on the grounds that an environmental right is not equally upheld for all.

The level of grassroots concern over environmental justice issues in the UK does not match that of the USA, where environmental issues have drawn the attention of the civil rights movement. However, environmental justice is a growing policy concern in the UK, one addressed by the 2005 National Sustainable Development strategy, which recognises that local environmental quality and access to environmental goods and services are determinants of health and quality of life, and that both are worst among socially excluded groups. The immediate response has been to focus on improving environmental quality in the most degraded and deprived areas, and to conduct further research to determine the most effective long-term remedial strategies. However, a wider range of remedial actions are available. In addition to raising environmental quality in selected areas, inequalities might be reduced through raising environmental quality overall. This sounds like a particularly appealing 'win-win' opportunity, but some political scientists have warned that social justice and environmental protection are mutually exclusive, based on a theoretical analysis. Based on limited evidence from air quality analysis (Walker *et al* 2003, Mitchell,

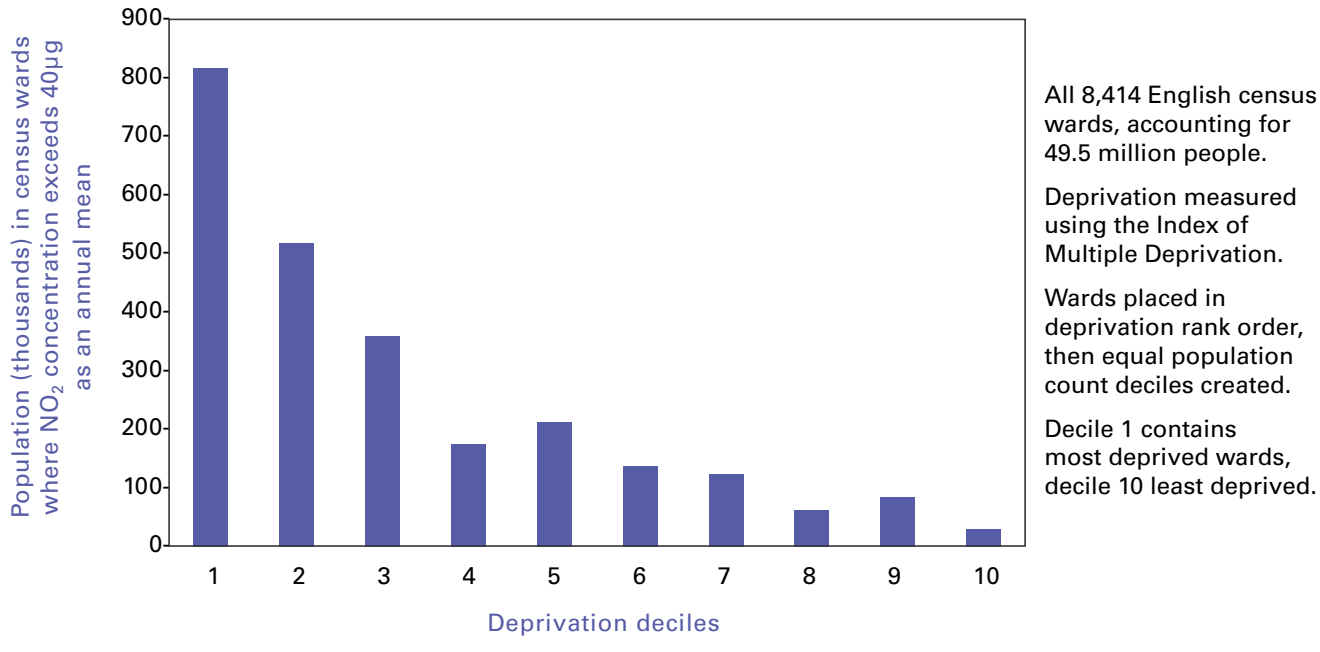


Figure 1: Social gradient of air pollution standard exceedence in England, 2001 (Mitchell and Dorling, 2003)

2004), the admonition seems overly pessimistic. Indeed, it seems likely that, for some environmental issues at least, raising standards for all will improve the environmental quality experienced by the most deprived.

An alternative interventionist approach would be to reduce the proximity of minority communities to environmental hazard. The planning system, for example, could be used to ensure that particular communities do not become 'hazard havens', where the presence of one noxious facility makes it harder to object to the development of others. There could be drawbacks to distributing hazards more widely: it could place more people in total at risk, lead to greater 'not in my backyard' consent difficulties, and deny deprived communities the wider benefits, such as jobs, that development projects might bring to an area. Conversely, the proximity of hazard to a minority community could be reduced by policies that increase the location options for minority households, and which encourage social mixing. Housing policy, for example, could ensure that new developments contain a significant share of social housing, a measure adopted in a number of Nordic countries. A further approach to tackling inequalities widely judged to be publicly unacceptable might be to provide compensatory benefits, which could take the form of enhanced community health, education or other public services. Finally, Good Neighbour Agreements are becoming more widely used in the UK. These are enforceable contracts that commit companies to demonstrating accountability to local communities. These agreements, which may be made a condition of planning consent, build trust and typically include specific commitments on the part of the firm (e.g. on discharges to the environment, risk appraisal) as well as procedures for oversight, such as the right of the community to appoint independent environmental and safety auditors, paid for by the firm.

While action may be needed to curb some of the most extreme localised cases of current environmental injustice in the UK, environmental inequalities seem unlikely to receive wider significant remedial attention. However, as we plan for three million new homes by 2020, it is legitimate to ask: what are the environmental equity and justice implications of such expansion? Will the environmental impacts fall disproportionately upon particular social groups, or will the costs and benefits of this new era of urban growth be experienced equally by all? In the National Sustainable Development strategy, government undertook to commission research into how current environmental inequalities arose. However, what seems to me to be equally (if not more) important is to understand how future environmental burdens will be socially distributed. That is, how will we ensure that development proceeds in a fair and environmentally equitable way, and that current inequalities are not exacerbated?

Thus a key goal in building sustainable communities is not just to identify the environmental impacts of development, but to understand who bears the brunt of those impacts. There are technical pitfalls of environmental equity appraisal to be aware of, but guidance on environmental equity assessment methodology is now available (Mitchell and Walker, 2007), and there is no need for environmental assessors to repeat the mistakes that muddied the evidence base for environmental injustice in the USA. Guidance addresses such issues of selection as an appropriate target community and environmental parameter, data quality, spatial units and comparison area, common statistical failings, and how to interpret findings. In the USA, a presidential order requires that all federal policies and plans are subject to environmental justice analysis to ensure that no minority group is exposed to disproportionately large and adverse environmental effects (President, 1994).

> "There remains limited potential for new urban development to degrade the environmental quality of the poorest districts any further…"

In the UK, no such substantive requirement exists, but there is plenty of scope for the inclusion of environmental equity appraisal in existing assessment frameworks. For example, the Strategic Environmental Assessment directive, merged in the UK with the prior requirement for sustainability appraisal of development plans, provides a clear mechanism through which the social distribution of impacts of regional spatial plans can be assessed. In addition, the New Approach to Transport Appraisal (NATA) is currently being refreshed so as to better consider distribution of impacts, among other things. In fact, a wide range of appraisal tools in the UK now recognise the importance of assessing distributive impacts (Walker *et al* 2004). This can in part be traced to the Treasury Green Book, which outlines government's approach to appraisal, and which clearly recognises the need to understand how the costs and benefits of public policy decisions are distributed.

Following the planning White Paper, and various efforts to speed up the planning process, it remains to be seen how deeply environmental equity assessment will be embedded in forthcoming appraisals of urban development. However, to ignore such distributive issues in the rush for urban growth could be short-sighted and prove a false economy, for while we have no substantive rights to environmental justice in the UK, as they do in the USA, we do have procedural rights. These rights are rooted in the Aarhus Convention on the Environment (UNECE,

1999), from which EU Directives on access to environmental information, and participation in environmental decision-making have since come into force. A third directive, about access to justice in environmental matters, has stalled due to disagreement between member states over who should be eligible to bring a case to court on the grounds of environmental injustice. The concern is that if all are eligible, the courts will be swamped and development paralysed.

In the UK, a process of judicial review already operates, which, it is argued, already provides access to environmental justice in cases of acts or omissions on the part of public authorities. The decision about which cases the court will accept includes a consideration of the standing of the applicant, and if there is a sufficient public interest. Where environmental issues are at stake, these criteria are interpreted generously by the courts, and no distinction is made between individuals or NGOs as to who has sufficient standing. This suggests that eligibility criteria should not limit access to environmental justice procedures in the UK. However, a major obstacle to access does remain: cost. For a handful, legal aid may be available, but for most potential applicants seeking environmental justice through the courts, the risk of losing and bearing all the costs is enough to put them off bringing a case. An Environmental Law Foundation study (Stookes, 2003) found that, of hundreds of claims that did not reach the court but had reasonable prospects of success, many were not pursued because of the prospect of a large, untold bill in the event of failure. In cases of overriding public interest, the court may decide not to award costs against a failed applicant, but of course this decision is only taken once the case is over.

The extent to which the Environmental Justice directive will address such difficulties is not yet known. However, in order to meet the spirit of the Aarhus convention and comply with its 'daughter' directives, the planning system should ensure that the public is actively involved in the development appraisal process, which should include a consideration of the distributive effects of proposals. Including the public in this process will lead to a better recognition of issues of concern to minority or socially excluded groups, and to developments that have greater public support. Of course, in a twist to this tale, it is quite likely that the middle classes will bear the brunt of the impacts associated with the three million new homes now being planned. Substantial greenfield development will be required, and the most desirable locations for developers are in the 'leafy suburbs', where good environmental quality and accessibility elevate property prices. If we consider urban development in England over the last 40 years, we can observe that it is indeed areas characterised as 'of average means' that bear the greatest share of the environmental impact of new development (Mitchell and Norman, in preparation).

However, it remains the case that the areas of worst environmental quality are those inner urban areas where poor communities are most often found. In effect, future urbanisation will most probably impact upon 'middle England' most, because there remains limited potential for new urban development to degrade the environmental quality of the poorest districts any further. The exception, of course, is the scenario of urban intensification, where denser living may entail more traffic congestion, with associated noise and emissions, and the loss of urban open spaces which provide critical social and environmental benefits to local residents.

◆ The author can be contacted at *g.mitchell@leeds.ac.uk*

References

CLG (2007) *About Housing* (www.communities.gov.uk/housing/about). Communities and Local Government website, accessed 21st December 2007.

Lucas K., Walker G., Eames M., Fay H., Poustie M. (2004) *Environment and Social Justice: Rapid Research and Evidence Review. Final Report.* Policy Studies Institute, London, 125pp.

Mitchell G. and Dorling D. (2003). An environmental justice analysis of British air quality. *Environment and Planning A*, **35,** 909-929.

Mitchell G. and Walker G. (2007). Methodological issues in the assessment of environmental equity and environmental justice. In Deakin M., Mitchell G., Vreeker R. and Nijkamp P. (eds.) *Sustainable urban development volume 2: the environmental assessment methods*, pp447-472, Abingdon: Routledge.

Mitchell G. (2005). Forecasting Environmental Equity: Air Quality Responses to Road User Charging in Leeds. *Journal of Environmental Management*, 77, 3, *212-226.*

President of the USA (1994) Executive order 12898 of 11th Feb 1994, Federal actions to address environmental justice in minority populations and low-income populations. *Federal Register* **59**, 32, 16th Feb, 1994.

Stookes P. (2003). *Civil law aspects of environmental justice*, Environmental Law Foundation, London.

UNECE (1999). *Convention on access to information, public participation in decision making and access to justice in environmental matters.* Geneva: United Nations Economic Commission for Europe.

Walker G., Mitchell G., Fairburn J. and Smith, G., (2003). *Environmental Quality and Social Deprivation. Phase II: National Analysis of Flood Hazard, IPC Industries and Air Quality.* R&D Project Record E2-067/1/PR1, The Environment Agency, Bristol.

Walker G., Fay H., and Mitchell, G. (2004). *Environmental justice impact assessment: an evaluation of requirements and tools for distributional analysis.* Report to Friends of the Earth, 76pp.

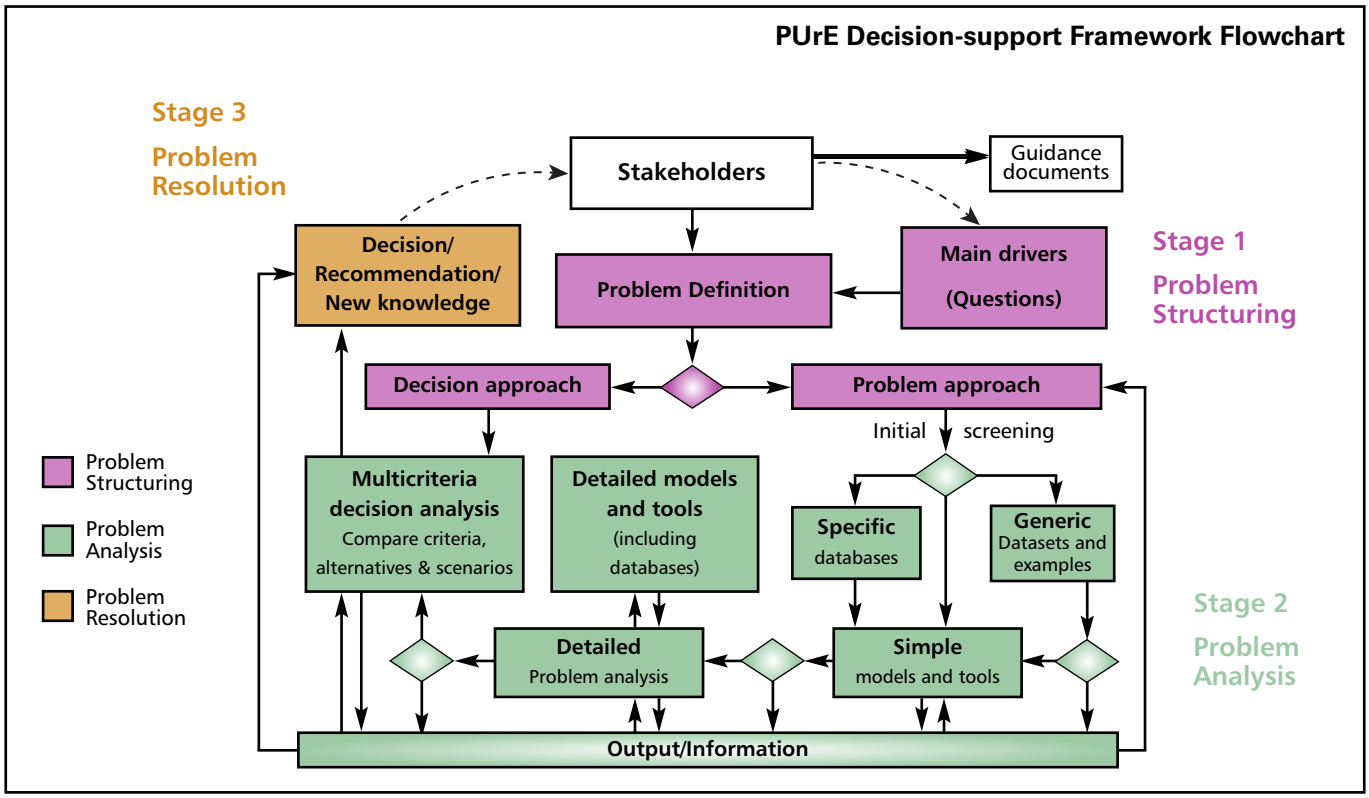
POLLUTANTS IN THE URBAN ENVIRONMENT

CAROL PETTIT outlines new tools that can be used to measure the impact of urban pollution

Urban areas can offer significant economic and social benefits; however, many urban activities are also a source of pollutants which can pose environmental challenges and potential threats to human and ecological health. There is a need to identify better options for management of the many sources and impacts of urban pollution. The current practices are often focused on specific environmental media (i.e. air, water or land), or on certain aspects of sustainability (e.g. economics). New initiatives are required to address the linkages between different environmental media, and to deal more effectively with the pollution arising from an expanding range of urban activities.

The **P**ollutants in the **U**rban **E**nvironment (PUrE) project is developing a new decision-support framework to enable more sustainable management of urban pollution. While such a framework cannot address every pollution problem, it can be used to address a range of different pollution problems and their potential impacts. The PUrE framework can be applied to examine the sustainability issues associated with pollution which arise from various urban activities (e.g. manufacturing, power generation, transport, waste management, etc) as well as the introduction of new products or technologies. A further application is the assessment of the potential effectiveness of policy measures and interventions intended to manage pollution, prevent impacts and reduce risks. Different users, including policy-makers, local authorities, industry, researchers and NGOs, can apply the new framework to conduct simple screening studies and/or more detailed modelling assessments of the sources, behaviour, and effects of urban pollutants. The project researchers are also developing a software modelling platform that incorporates a suite of data sets, models and tools, along with framework guidance and user manuals. Several of the examples and case studies developed during the project are outlined below.

The new framework provides an integrated approach for the definition of the urban system, and facilitates the comparison of different pollution management options based on all aspects of sustainability (i.e. environmental, social and economic). The first step is to identify the stakeholders and their key questions about urban pollution. The associated sustainability issues and indicators are



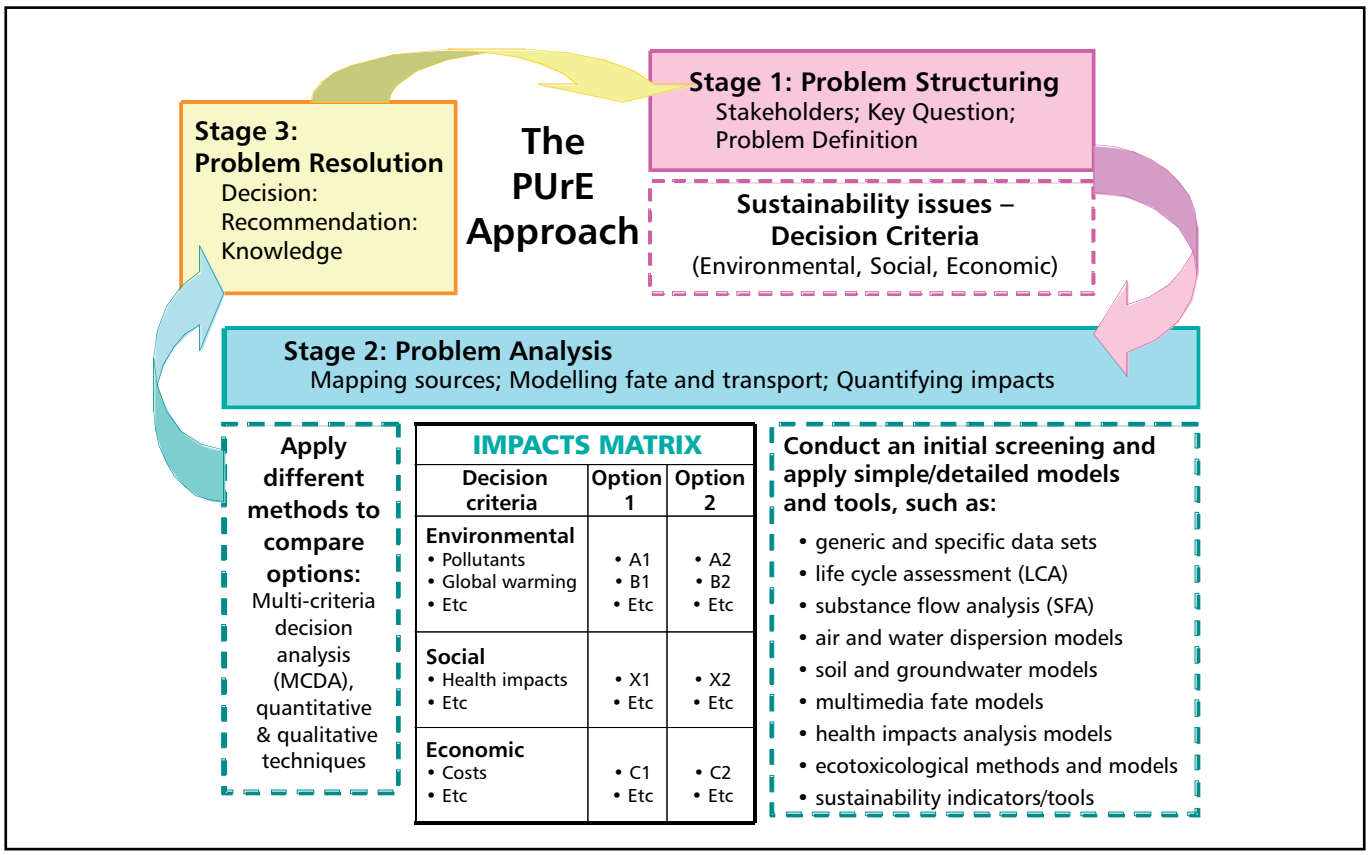
later used as the decision criteria in the decision-making step of the framework. The analysis of the pollution problem typically begins at a screening level, to identify the important factors. It can then progress to using either simple or detailed models to characterise the sources of pollution, examine the movement of pollution through the environment, and predict the potential effects and impacts of pollutants on the local area as well as the wider (global) environment.

The models and tools included within the PUrE framework approach include: datasets and models for characterising sources (emissions) of pollution; Life Cycle Assessment (LCA) modelling for predicting the environmental burdens and impacts; Substance Flow Analysis (SFA) for tracking the flows of pollutants; Geographical Information System (GIS) features; dispersion models for characterising the transport of pollutants through environmental media; human Health Impact Analysis (HIA) models; Ecological Impact Assessment (EIA); uncertainty analysis, and multi-criteria decision analysis (MCDA) techniques for comparing the options. This new integrated approach will provide a more scientific and transparent basis for comparing the effectiveness and sustainability of different pollution management options, and also for communicating the findings and recommendations to the stakeholders.

Two detailed demonstrations, or 'test beds', have been developed to illustrate the PUrE framework methodology, for a hypothetical city called 'PUrEham'. However, real datasets were used to prepare these two examples.

Test bed #1 examines more sustainable options for the thermal treatment of municipal wastes, and compares using a large-scale facility (incinerator) to several smaller-scale (pyrolysis) units; this example looks at the levels of key pollutants associated with transport and management of the wastes, and the use of vegetation to intercept particulates, thereby reducing their concentration.

Test bed #2 examines more sustainable options for production of energy, and compares building a new biomass facility against expanding use of an existing coal-fired power plant; this example looks at the impacts of specific pollutants, associated with transport of the fuels to the stations and generation of power, on the health of the local urban communities and terrestrial ecology in the vicinity of the power station.



Four real life case studies explore various urban pollution issues. These case studies have been developed in collaboration with the PUrE consortium partners and other stakeholders, and will be published in due course.

The **Sheffield** case study looks at the contribution of different sources and mixtures of pollutants to environmental impacts and human health. The research also involved the monitoring and characterisation of deposited mixtures of particulate matter (PM_{10}) to identify the possible sources (i.e. by examining photographs to look at the shapes and by analysing the composition of particles).

The **London** case study examines the role of urban greenspace as a means for reducing the local levels of particulate (PM_{10}) pollution and providing health benefits; this example illustrates the PUrE approach for mixtures of pollutants.

The **Avonmouth** case study involves an investigation of legacy pollution in an industrial area, and will illustrate the effects of several regulatory/policy-related changes and technical interventions carried out on an historic smelting facility. The study plans to look at the potential effects on human health under the different operating scenarios, as well as the potential risk to ecological receptors from metal deposition to soil (e.g. arsenic, cadmium, zinc, lead).

The **Siracusa Sicily** case study looks at legacy hydrocarbon pollution in an industrial harbour area, and will illustrate how the PUrE framework methodology can be applied to compare different remediation technologies and options proposed for more sustainable management of the contaminated groundwater.

In summary, the PUrE framework offers an integrated approach that can be used to address the environmental health implications of multiple forms of pollution in the urban environment, as well as a modelling platform for integration of several different tools that can be applied to evaluate more sustainable options for management of urban pollution and its effects. The other benefits of the PUrE framework are that it will enable structured, transparent and informed decision making. If you would like to know more about the PUrE framework or the case studies, please visit the project website: *www.pureframework.org*

PUrE is a consortium research project funded by the EPSRC (Engineering and Physical Sciences Research Council) under the Sustainable Urban Environment (SUE) Programme. The research is led by the University of Manchester and conducted in collaboration with Cardiff University, the London School of Hygiene and Tropical Medicine, Forest Research, Sheffield University, Exeter University, and the University of Surrey.

Many non-academic partners and key stakeholders participate in the PUrE consortium project and Steering Group. The PUrE International Conference on the Impacts of Pollution in a Changing Urban Environment will be held from 17th to 19th September 2008 in Manchester; please visit *www.pureconference.org.uk*

◆ Carol Pettit is PUrE Project Coordinator.

INTELLIGENT OFFICE DESIGN FOR URBAN SUSTAINABILITY: CASE STUDY

DR STELLIOS PLAINIOTIS

explains how the intelligent application of sustainability concepts produced a prize-winning office building

Offices, as a category of building, have faced many challenges and undergone dramatic changes in the last few years due to recent technological advances, economic globalisation and demands for ever higher standards of sustainability. Sustainable office design is partly about reducing the impact of the building on the environment; it is also about achieving high levels of thermal comfort, exploiting natural daylight and air quality. In addition to the environmental and social benefits, the business gains of operating sustainably are increasingly apparent.

The annual MIPIM Architectural Review Future Project Awards[1] are presented to future or undeveloped construction projects, in eight construction categories. These are: office; retail and leisure; regeneration and masterplanning; mixed-use; big urban projects; residential; tall buildings and sustainability. With reference to the case study of 'Amazon Court', the design that won this year's awards for the office category, this article will demonstrate some principles and methods behind the introduction of simple but powerful and intelligent sustainability concepts into office building projects. Amazon Court is a good example on account of its plethora of unique and innovative sustainable design techniques, from simple and passive utilisation of nature to systematic design. Situated in the Czech capital, Prague, Amazon Court was designed by an international team of designers and engineers lead by Danish architects Schmidt Hammer Lassen (SHL)[2], the London-based engineers Battle McCarthy (BMC)[3] (early concept design) and Zero Energy First (ZEF)[4].

Case study: Amazon Court, Prague

Amazon Court is a combination of an office building and a public square. The international design team aimed not only to create modern office working conditions with high

Figure 1: The heart of Amazon Court is a large, south-facing buffer atrium – a seven-storey tall, 32-metre wide public space which opens itself towards the sky

standards of finish and flexibility, but also to incorporate environmental considerations, all at low cost. The client wished to create an adaptable environment that embraced Western European low-energy, modern design solutions, and coupled these with standard Central European requirements.

The design presents a simple exterior, featuring a vertical façade in local stone, and large apertures in order to establish close connections between the external and the internal environment. The flexible structure of the building surrounds a large atrium, with parts of the office facilities floating like hanging terraces and gardens spanning across the atrium space; thus, the overall effect is of a unique, glass-covered public park.

Completion is scheduled for the fourth quarter of 2008, and will offer about 17,500 m² of office space on six floors, as well as over 250 parking spaces in the underground garages. The typical size of the office floors is nearly 3,000 m², while the ground floor will comprise around 2,000 m².

Sustainable design strategy

The environmental design features of the Amazon Court complex touch all parts of the building complex: the site, the building envelope, the atrium void, the ventilation system and the office lighting systems. The compact layout minimises the heat loss from the building and secures close contact with the atmosphere of the winter garden, and also provides visual contact with the riverbank for as many users as possible.

The atrium construction is both an unusual and an energy-saving solution which permits an adjustable degree of sun screening. This is just one of a number of measures which, together, give Amazon Court a sustainable profile: natural ventilation, active temperature reduction during the night hours, low operating cost and cooling through the exploitation of temperature differences with the nearby river. The following strategies were adopted to safeguard low resource consumption:

- Brownfield site remediation
- Atrium design
- Intelligent ventilation system
- Thermal mass
- Night ventilation
- Passive cooling
- Geothermal energy
- Indoor environment quality.

The site

The 2002 World Summit on Sustainable Development[5] listed three foci for sustainable development:

1. eradicating poverty;
2. protecting natural resources; and
3. changing unsustainable production and consumption patterns.

Redevelopment of 'brownfield' sites and sustainable building construction are two concrete applications of this concept. The Czech Republic is one of a number of countries in the EU that continues to pay for past negligence. One example has been the failure to clean up brownfield sites that continue to be a blight on the country's landscape and sometimes a serious health risk. For historic reasons, many of the country's most dilapidated zones, such as abandoned industrial zones or former storage areas, are found in picturesque or highly visible areas in towns and cities[6]. Large and experienced developers in Prague are beginning to focus on the redevelopment of such sites.

Situated on the riverside of Vltava, in the northwest Karlin district of Prague, Amazon Court is the third building developed within River City Prague after Nile and Danube House. For decades, the site was brownfield land, contaminated by illegal dumping and industrial activities[7]. In addition, the neighbourhood was one of the city's worst affected areas in the massive flood of July 2002. Facilitating environmentally responsible land redevelopment and revitalisation was therefore one of the Amazon Court project's main objectives.

Atrium design

An atrium can be described as a courtyard space covered by a glazed roof and/or windows that open to the sky and reveal the building's internal functions. Courtyard buildings extend back to ancient civilisations based in warm climates, including those of the Greeks and Romans, where the central court performed important social and space conditioning functions[8]. The 19th century brought the Industrial Revolution, with great advances in iron and glass manufacturing techniques that allowed for courtyards to have horizontal glazing overhead, thus eliminating some of the effects of weather on the space, and giving birth to the modern atrium. Over the last 40 years, atrium design has become one of the most popular architectural forms in major office building projects[9].

The heart of Amazon Court is a large, south-facing buffer atrium – a seven-storey tall, 32-metre wide public space which opens itself towards the sky (Figure 1). The atrium is naturally lit by various means and allows natural light to penetrate to the offices. The atrium is covered with a lightweight, transparent construction made of Foiltec[10] roofing/cladding material, which admits daylight and enables passive solar heating in the winter.

The atrium also integrates natural ventilation into the design for a comfortable space during moderate periods of the year, and serves as a passive environmental space, a winter thermal buffer and, in summer, as a heat dissipater. The atrium's natural elements such as water, intimate terraces, and vegetation, all construct a bioclimatic buffer zone and enhance biodiversity which includes both plants and animals (e.g. insects).

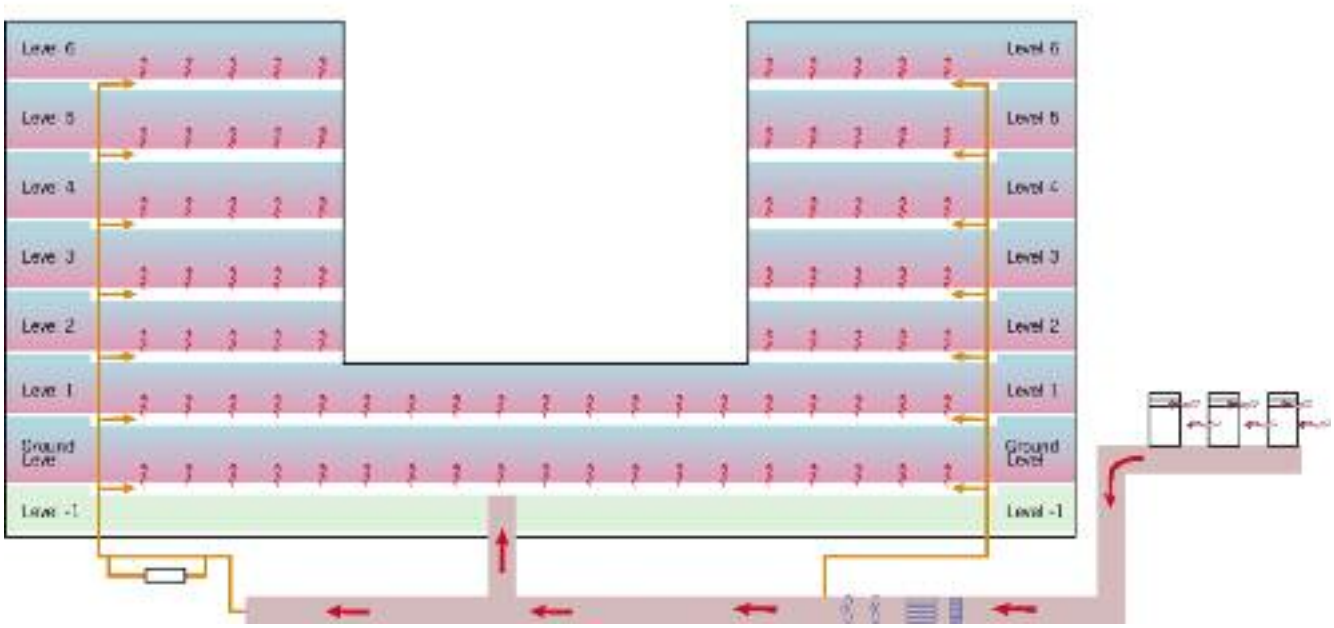


Figure 2: Overview of the ventilation strategy

Ventilation strategy

Ventilation in office buildings can account for between 30% and 50% of their total energy consumption[11]. Therefore, significant additional reductions in energy consumption would be achieved if mechanical ventilation is minimised and full use of the atrium is made. Control of air-movement in the complex would also play a significant role in the internal conditions, given the broad range of ambient conditions of Prague's climate, characterised by very cold winters and warm, fairly humid summers.

Ventilation within the atrium during the natural ventilation periods (modes of operation) is achieved simply by openings in the atrium's secondary façade that faces the river (North), and a series of high level openings at the office interface line above roof level (Figure 2). However, the atrium will run under a mixed-mode strategy, meaning that under more severe winter and summer conditions it will be sealed up and mechanically ventilated. In addition, high levels of airborne pollution and noise from the adjacent busy riverside road (Rohanské náb eží) mean that the façade facing the road needs to be sealed.

The ventilation strategy was designed for a minimum of four air changes per hour (ACH) in the external office bay zones and atrium office bay zones, as well as in the central office bay zones, and for two ACH in the internal corridor zones. In the offices, air is supplied via the underfloor displacement system, with a fixed supply temperature of 18-20°C, and the air enters the space via circular floor diffusers (Figures 2 and 3). Exhaust air is also discharged into the car park areas to control conditions in these spaces during ambient extremes.

Thermal mass

Thermal mass refers to the combination of all the construction materials able to absorb and store heat. Since ancient times, massive materials (walls of adobe or stone) have been used to moderate temperature swings, to absorb the sun's thermal energy and to release the stored heat to warm living spaces.

Amazon Court incorporates significant areas of thermal mass, particularly with the exposed ceiling soffits combined with the use of an underfloor ventilation system. The exposed ceiling soffits absorb the heat from the office space during the day. In addition, natural night ventilation cools down the exposed structure which has accumulated the heat of the previous day. The combination of exposed ceiling (or no false ceiling) with underfloor ventilation and night cooling is expected to reduce the peak cooling/heating loads by as much as 20%.

Passive cooling

The office occupancy patterns, which include long unoccupied periods, make night ventilation an effective ventilation strategy for Amazon Court. In moderate climates, one promising approach to reducing the energy demand of office buildings for air conditioning without reducing comfort is passive cooling by night ventilation[12]. Night

cooling techniques in Amazon Court are expected to offer various advantages[13]:

- Because of the lower night-time temperatures, the temperature difference between inside and outside will be greater, enhancing both the stack-driven flow rates and the cooling of the outside air.
- By cooling the fabric of the building in this way, the mean radiant temperature of the space is reduced, improving thermal comfort the following day.
- By ventilating during unoccupied periods, the potential problems of draughts and noise in the occupied space are avoided.

Geothermal energy and energy piles (boreholes/heat pumps)

Air heating and/or cooling in an earth-to-air heat exchanger reduces energy consumption and improves thermal comfort in a building. Energy piles are an efficient method of storing heat. They have a double purpose: to load transmission into the foundation soil, and to be used as energy exchanging elements for sustainably heating and cooling buildings[14].

Five boreholes were strategically placed around Amazon Court on the outside of the sheet piling and slurry wall construction line. These boreholes were drilled to 25m depth and take groundwater from above the substratum of clay-slate. This water is pumped from the boreholes to a sub-basement heat-pump plant. From here, once heat exchange has occurred within the heat-pump plant, the groundwater is pumped back into the river via a specially licensed agreement.

Indoor Environment Quality

During the last decades, the significance of Indoor Environment Quality (IEQ) in office buildings has been appreciated, not only in relation to thermal comfort, but also to lighting and indoor air quality. Providing higher standards of IEQ in office buildings leads to improved health, productivity and reduced obsolescence, which in turn translates into higher rents, stronger rental growth and higher capital values[11].

Many office buildings employ recirculation of conditioned air as an energy efficient measure to reduce the intake of 'fresh' outside, unconditioned air. Air recirculation, however, causes accumulation of airborne contaminants, often leading to poor air quality and a phenomenon called 'sick building syndrome'. The selected office internal comfort control system in Amazon Court includes

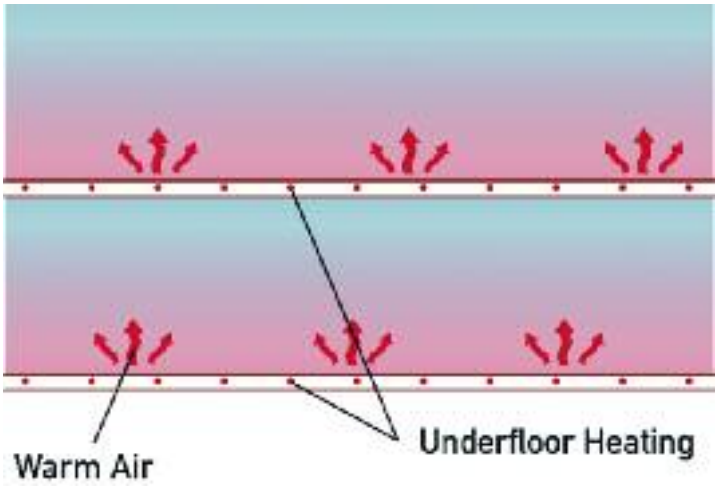


Figure 3: The air enters the space via circular floor diffusers

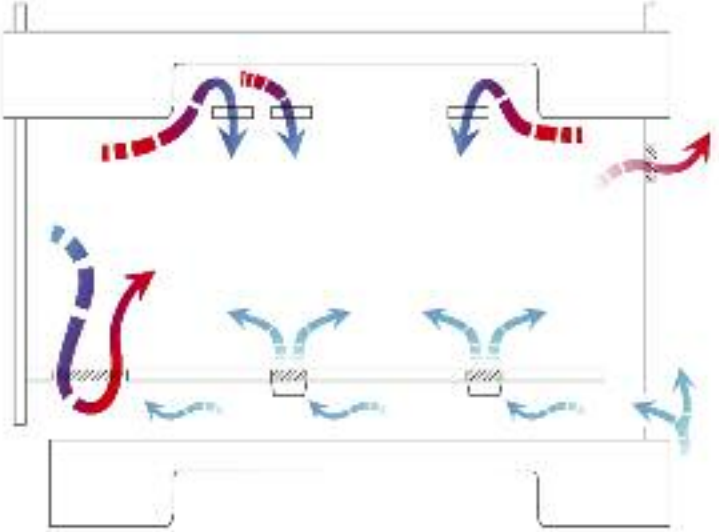


Figure 4: The displacement 'all fresh air' floor supply system

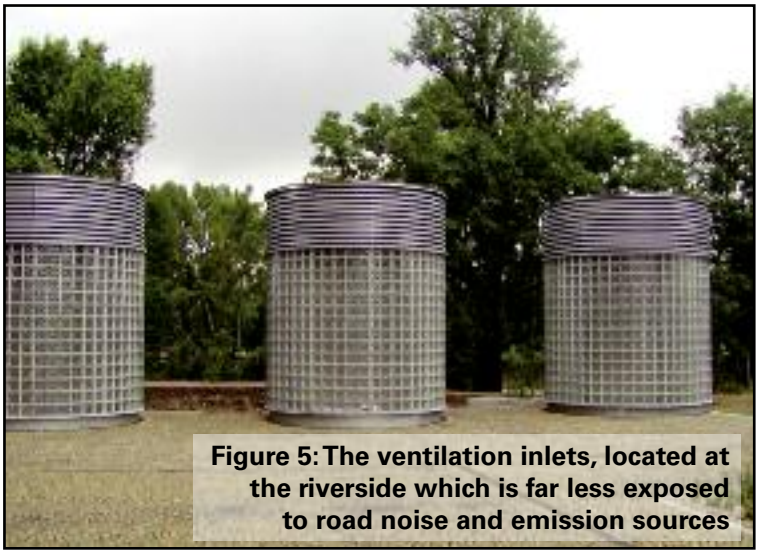


Figure 5: The ventilation inlets, located at the riverside which is far less exposed to road noise and emission sources

a 100% fresh air system, which means there is no air recirculation and an inherent reduction of airborne pollutants. In addition, natural daylight is maximised by the atrium design and thermal comfort is secured by the displacement 'all fresh air' floor supply system, ducted extract air and perimeter heating to external office zones (Figure 4).

Air is channelled from the riverside to supply the atrium and the systems, thereby taking advantage of the natural cooling and pollutant removing effects of the river and the riverside open space vegetation (Figure 5). This side of the building is far less exposed to road noise and emission sources. In parallel with this exercise, the thermal mass of the exposed concrete soffit will offer radiant comfort benefits. The gardens in the interior of the atrium are also expected to improve the air quality inside the building, increase the oxygen content and remove airborne pollutants.

Summary

This article demonstrates that more resource efficient and sustainable offices make financial sense to occupiers, investors and developers alike. This is particularly apparent in the city of Prague, amid the city's changing post-socialist patterns of urban development. Increasingly strict legislation will be a key driver towards forcing office buildings to be more sustainable, combined with an increasing demand among occupiers for more sustainable offices.

Amazon Court deservedly won the MIPIM AR Future Projects award because it represented precisely that, the office building of the future, one that illustrates how sustainable practices can be built into excellent design.

◆ The author can be contacted at: *splainiotis@zefltd.com*.

Drawings and construction photos were provided by Zero Energy First (ZEF) Ltd and the renderings by Schmidt Hammer Lassen Architects.

References

1. MIPIM Architectural Review Future Project Awards 2008 (available online at: *www.arplus.com/MIPIM/index.htm*)
2. Schmidt Hammer Lassen Architects, clemensborg aaboulevarden 37, PO box 5117 dk-8000 aarhus c
3. Battle McCarthy (BMC) Ltd Dog and Duck Yard, Princeton Street, London WC1R 4BH
4. Zero Energy First (ZEF) Ltd, 1-3 Dufferin Street, London EC1Y 8NA
5. World Summit on Sustainable development (WSSD) Johannesburg, 26th August - 4th September 2002. *www.worldsummit2002.org* (accessed in March 2008).
6. Jan Velinger (2006): 'Brownfields' a common blight on the Czech industrial landscape. Radio Praha, 11-03-2005. (available online *www.radio.cz/en/article/64287* accessed in April 2008)
7. The Prague Environment Yearbook 2006 – Atlas of the Prague's Environment, City of Prague, CD ROM and internet: *www.premis.cz/atlaszp/en_default.htm*
8. Brian Edwards, Magda Sibley, Mohammad Hakmi, Peter Land (2005): *Courtyard Housing: Past, Present and Future*, Taylor and Francis, ISBN: 978-0-415-26272-9
9. Saxon Richard (1994): *Atrium Comes Of Age*, Pearson Professional Education, ISBN: 0582093856
10. FOILTEC, *www.foiltec.com*
11. Ji Yan and Plainiotis Stellios (2006): *Design for Sustainability*, China Architecture and Building Press, ISBN 7-112-08390-7
12. Kolokotroni M. *et al* (1998): *Summer cooling with night ventilation for office buildings in moderate climates*, Energy and Buildings, Volume 27, Number 3, June 1998, pp. 231-237(7)
13. Pfafferott J, Herkel S and Wambsganß, M: (2004). *Design, monitoring and evaluation of a low energy office building with passive cooling by night ventilation*, Energy and Buildings, 36, pp455- 465.
14. Katzenbach R., Knoblich K., Mands E., Rückert A. & Sanner B. (1997): Energiepfähle – Verbindung von Geotechnik und Geothermie. – Ber. Symp. Erdgek. Wärmepumpen 1997, Ber. IZW 2/97, S. 91-98, Karlsruhe

CHANGING THE FACE OF THE CITY, ONE IDEA AT A TIME

Advanced technology and lateral thinking can both make our cities cleaner and safer. **HARRY JOLL** looks at new ways of improving the urban environment

The urban environment, like any ecosystem, is defined by the relationships within it. Populations, nature, machines and buildings all need to co-exist within limited space. Achieving harmony, preferably in an efficient, aesthetic and sustainable way, requires vision. A multitude of considerations, from transport to waste, from housing to energy demand, jostle for the attention of designers and legislators. Gathering examples from different countries and different schools of thought, however, it becomes clear that the most successful approaches are the most holistic. Designers involve communities; architecture and the natural world are both respected; and simple, efficient planning allows us to retain high standards of living. From whole cities to one street at a time, this article examines some of the most pioneering ideas at work to make the urban environment sustainable.

Safe, clear streets and cars are often treated as being mutually exclusive in urban centres. Responses to concerns about road traffic accidents have included the imposition of low speed limits or the complete exclusion of vehicles from key areas. Hans Monderman, a Dutch traffic engineer, thought differently. Rather than attempt to meet every potential decision or accident a driver might face with a barrage of signs, regulations and barriers, he experimented with cutting back on such street furniture. He replaced it with two things: design, in the use of natural landscapes, lighting, art and local materials; and faith in old-fashioned common sense, encouraging drivers to take more responsibility for their decisions, a process now known as psychological traffic calming. How did Monderman, who let's remember was a traffic engineer, test these radical ideas? By walking backwards into traffic and holding interviews on intersections, how else?

Cynicism would have been understandable, but when the strategy was piloted, in areas ranging from the village of Oudehaske to a dense intersection in the town of Drachten, there were soon fewer accidents, less congestion and more attractive public spaces. Monderman's influence has manifested itself on some major UK streets, like Kensington High Street in London, or New Road in Brighton.

The developing Hammarby Sjöstad suburb of Stockholm aims to use half the energy and water of other newly constructed housing in the city. It's an ambitious target, but the project is on course: in 2002, 34% of Hammarby Sjöstad's heating came from purified waste water, 47% from combustible household waste and 16% from biofuel. The project is a tour de force of good environmental planning. Only old 'brownfield' sites have been built on, transformed into residential areas and green public spaces. A fast, efficient public transport system, car pools and cycle paths have all been in place from the beginning. However, these are only the foundations for a truly integrated, multilateral model for low-carbon development.

New technology is important – the solar panels which supply energy to some larger residential buildings, for example – but it is the synergy of Hammarby Sjöstad that really impresses. To illustrate: waste is rigorously separated at source before entering recycling streams. An extraordinary network of underground pneumatic tubes collects and transports combustible waste, most of which goes on to be incinerated to produce heating and electricity. Food waste is currently composted, but the ultimate aim is to convert it into biogas and bio-fertilisers. If this was successful, it would feed into yet another local energy cycle. About 900 flats in Hammarby Sjöstad have cookers that run almost entirely on biogas, produced when sludge from the waste water treatment is digested by microorganisms. The biogas generated by the average family is almost equal to the amount of biogas they use for cooking, and thus electricity use has been lowered by 20%.

In the UK, the sustainable transport charity Sustrans has been pioneering more of a bottom-up approach through its Liveable Neighbourhoods project, which combines urban planning, community involvement and sustainable transport. One of its initiatives, DIY Streets, helps residents to redesign their own streets affordably, making them safer and more attractive. Simplicity is at the heart of the scheme, a virtue which also helps to keep costs down: the redesign is relatively straightforward, the materials basic but durable. Vitality and variation have proved to be two effective ways of sending a clear message to drivers that an area is residential and in use. Children playing, neighbours talking, colourful houses, flourishing gardens, pedestrians and cyclists all encourage lower speeds and greater watchfulness. Roads can be narrowed to make them harder to negotiate, commanding greater attention from drivers. Sightlines can be reduced so vehicles have to slow down to allow for unseen traffic.

DIY Streets has more in common with Modernman than it might appear, as design trumps regulation when it comes to reducing speeds and easing parking density. Speed humps are familiar, but if well-designed and posi-

tioned less frequently along streets where little else is possible, they can also serve as crossings for pedestrians. Similarly, chicanes combine narrower widths and reduced sight lines to slow traffic and provide safe crossings. Aesthetics have a key role to play too. Greenery makes a street more attractive and reduces traffic speeds, whilst benches positioned under trees means residents can enjoy the street and the shade. 'Gateways' use artwork to identify an area, alerting drivers when they enter a residential area. DIY Streets will initially be piloted in ten communities, and there seems little reason why it could not be replicated all over the UK and beyond.

Some approaches to the sustainable design cities operate on an altogether larger scale. The 'Slow City' (Cittaslow) movement is a reaction against the hectic homogeneity that so many urban centres have become. Its philosophy posits that places, people, food, architecture and crafts are the lifeblood of a city, so should be prized accordingly, and people should be given the time and space to enjoy them. The manifesto for eligibility contains more than 50 pledges, the most important of which are reducing noise and traffic; increasing green spaces and pedestrian zones; supporting local production; and preserving local aesthetic traditions. Only cities with a population of under 50,000 can be awarded official status.

Bra is one of more than 30 Slow Cities in Italy, where the movement grew out of its Slow Food counterpart. It has banned cars, supermarkets and their garish paraphernalia from parts of its historic centre. Small family-run businesses, selling handmade produce as a rule, are allocated the choicest sites. City Hall subsidises building renovations that use the honey-coloured stucco typical of the Piedmont region. Schoolchildren are given locally grown, organic fruit and vegetables. The Slow City manifesto can seem authoritarian and proscriptive, hostile to modernity. However, its supporters would say that targets need to be both far-reaching and stringently adhered to if the movement is to have a real impact on city life. Furthermore, the idea is not to reject modern life, but to balance its privileges with its pressures. Indeed, appropriate technology is vital to the success of Slow Cities: electric buses help Orvieto in Italy to achieve silent, low-emissions transport, and the internet has been the primary tool for spreading the word. The Slow Cities movement now has networks in England, Wales, Germany, Norway, Poland and Portugal, with other nations keen to follow suit.

Concern about traffic and urban sprawl in the USA during the early 1980s gave rise to 'new urbanism'. Also known as 'infill', this design movement creates dense, efficient neighbourhoods, where distances between housing, jobs and amenities are kept to a minimum so as to encourage walking. The Congress for New Urbanism (CNU) has grown to more than 3,000 members, and advocates accessible neighbourhoods with diverse populations and community spaces. Like Cittaslow, the CNU Charter emphasises that 'urban places should be framed by architecture and landscape design that celebrate local history, climate, ecology, and building practice.'

Similar concerns, more specifically about the dire traffic situation, prompted a mechanical solution in Copenhagen. The first of three fully automatic parking systems, offering around 800 parking spaces, will open in 2009. Several levels will be served by four car lifts that will take each car down to an allocated space and later bring it up again. The benefits are that parking will take up less space and time, freeing up the streets for pedestrians. The environmental credentials of such a scheme appear questionable, especially manufacturer Westfalia's claim that 'cars parking in and out or driving around in search of parking is avoided both on the street and in the garage, there's much less pollutants'. It hardly seems likely that facilitating parking will reduce car use, but the more efficient use of space is commendable, and other Scandinavian cities have expressed interest.

Cities have steadily expanded over the course of recent centuries, attracting ever greater numbers. In 1800 only 3% of the world's population lived in cities; today it is more than 50%. They have come to be seen as national centres as a result: of finance, culture and power. Expansion has always had its costs, however, and those seem to be increasing in scale just as fast as the urban centres themselves. Some ready contemporary examples include air quality in Los Angeles, congestion in London or rubbish disposal in Naples. As urban populations increase and the pressures on local (and global) environments increase, architects and policy-makers need to adapt accordingly. The task of collating and integrating infrastructure, inhabitants, their modes of transport and the natural environment is an ever more demanding one.

Holistic solutions are the most promising: witness the achievements of the Hammarby Sjöstad development or the Slow City initiative. On the other hand, smaller-scale innovation is invaluable as a means of involving local communities, or tackling one problem at a time. Ideas on both macro and micro scales are needed, and they are needed in tandem, if we are to meet the challenge posed by the spiralling impact our cities are having on the wider environment, and vice versa.

As this article and several others throughout our urban environment series have shown, good design and integrated planning represent progress in the true sense of the word. Far from requiring sacrifice, environmental improvement makes cities safer, healthier, more attractive, fairer, more efficient and cost-effective over the long term. The time has come to dismiss the notion that sustainability and standards of living are in opposition, and recognise that they are one and the same.

◆ The author can be contacted at *h.joll@ies-uk.org.uk*

PRESERVING OUR HISTORIC URBAN ENVIRONMENT

Restoring old buildings in our cities can prove costly – but it brings social and ecological rewards, say **DR CARLY BROOKS** and **DIANA BEATTIE**

A city's buildings and monuments constitute an important part of its landscape, but the urban environment is about more than appearance. Urban conservation protects precious, irreplaceable links to previous eras, and governs how urbanites interact with the history of their towns and cities. Architectural heritage not only adds to local character, it fosters a sense of national and community identity. By imbuing inhabitants with a sense of continuity with the past, heritage gives them a stake in both their present and future.

London is a perfect example of a city where heritage is a key part of the urban environment: an iconic capital of the modern world, London's diverse and historic character is surely worth saving.

London encompasses a diverse geographical area. The human landscape developed over nearly two millennia, sculpted by and in turn influencing the ancient landscape of the Thames basin. Contemporary London is located on the Roman site of Londinium, although its roots are more ancient even than that. Although little is left from this era, many areas around the city have names which reveal their Roman origins.

Understanding human activities throughout ensuing historical periods helps us make sense of the differences in building styles, the alignment of roads following ancient property boundaries and the location of churches, once the centres of outlying villages, now absorbed into the city. Long lost trades, activities and uses for various areas in the city are reflected in the street names, particularly those in place before the 19th century, after which it became popular to name streets after renowned historical figures.

Little remains of medieval London. The Great Fire of London in 1666 prompted rebuilding on an unprecedented scale. The 18th and 19th centuries saw the rapid expansion of Georgian and later Victorian London. Money flooded into London from colonial trade, the commercial successes of the early industrial revolution and later global trade. Victorian London was transformed into the world's largest city and capital of the British Empire, becoming the centre of economics, politics, trade and finance.

The city underwent its most intense period of growth during the 20th century, a period which also saw dawning awareness of the importance of historical buildings in London. The 'Georgian Group' was formed in the city in the 1930s in response to the destruction of Georgian buildings thought to be dull and lacking merit. Since that time, many more voluntary groups have been established to protect different facets of the heritage of London, the historic aspect of which enriches the quality of life of Londoners today.

Restoring old buildings can also yield ecological rewards. Concerns about energy use and sustainability are commonplace when it comes to modern buildings, which consequently tend to be more efficient than their older counterparts. However, this comparison is generally based on energy consumption, and not a comparison of energy embodied in new construction against that of pre-existing buildings. When restoring older buildings, we preserve this embodied energy as well as averting energy costs entailed in diverse activities from demolition to site clearance, removal and transport of spoil and replacement materials, and the costs of new construction. Offset against these embodied energy benefits are the greater energy costs often entailed in running older heritage sites due to inadequate insulation.

This operational inefficiency compared to more modern buildings, combined with greater density of use and occupancy in modern designs, may result in increased long-term energy costs in re-using heritage buildings. Careful planning is required to successfully mitigate these increased energy costs by introducing efficient conservation techniques, compatible with the preservation of sites that are culturally and historically important. One also needs to consider the trade-off between construction and renova-

The Clapham Orangery: undergoing restoration by the Heritage of London Trust

tion. In 2005, the Empty Homes Agency conducted research into the environmental impact of new build, as opposed to refurbishment. The results suggested that constructing a new house produces roughly six times more carbon dioxide. Such a pronounced disparity could prove to be crucial, but more research is needed before firm conclusions can be drawn, and factors such as the superior insulation of new housing taken into account.

In Vienna, the use of renewable energy sources in urban restoration projects has proved to be an effective means to mitigate these energy requirements. By implementing a subsidised urban building renewal programme, based on using low-carbon sources of energy, the city successfully decreased both fossil fuel consumption and carbon-based emissions. Another example of successful, environmentally beneficial regeneration is Ireland's historic Temple Bar in Dublin. Saved from plans for its demolition and replacement, the site was restored sympathetically using energy-efficient materials, solar panels, photovoltaic and wind energy systems. Renovation of a heritage structure using 'green', 21st century processes and materials helped reduce lifetime energy costs by 80%, while preserving the historic and cultural attributes of the building.

Preservationist groups have much in common with environmentalists. The restoration and conservation of buildings can constitute sound management of valuable resources, as well as reducing energy costs and the associated 'carbon footprint'. This provides a compelling case in favour of conserving older buildings.

However, we have also to consider the higher costs of regenerating existing buildings, which may require traditional materials and skilled craftsmen. For example, even a straightforward project like replacing a church roof can cost upward of £500,000. Over the past decade, government funding for heritage has dropped by over £100 million according to Heritage Link, though The Heritage of London Trust estimates that the figure is much higher. This has meant a pronounced reduction in restoration and repair grants from key organisations like English Heritage and the Heritage Lottery Fund. The renovation of historic buildings could be regarded as a large-scale form of recycling. When you consider the support of citizens for their heritage buildings, it seems short-sighted to curb funding so dramatically without a broad appraisal of the cost of other options.

In London, heritage buildings also provide inspiring spaces for community groups and charities to meet. This is due to a range of factors including their size, their historic associations and, in part, to the high quality of building in Victorian London. Such heritage buildings are the site for a great deal of community service and welfare work. The historic building becomes a focus for community spirit in an increasingly frenetic and fragmented urban environment.

English Heritage and ICOMOS (the International Council of Monuments and Sites) are leading the campaign to raise awareness about the loss of historic views across London, but other environmental issues are not being adequately addressed. It is important to consider the effects of more recent tall buildings on the local micro-climate; the huge swathes of shadow that they cast, the funnelling of strong winds; and sprawl upon London's floodplains which can only exacerbate flood risk.

The 'energy bank' represented by older existing buildings – which could provide a sustainable, energy-efficient way of sensitively developing urban areas if effectively tapped into – needs to be given as much consideration as the protection of our cities' heritage into the future.

The Heritage of London Trust covers all the Greater London Boroughs, and exists to preserve the best of the past in a magnificent and historic city. The trust offers grants towards the restoration of historic or listed buildings and monuments that are in some form of community use. The trust was set up in 1980 to support heritage buildings which are held, used and maintained by the local communities. (*info@heritageoflondon.com*)

IES: NEW MEMBERS

The Institution of Environmental Sciences is pleased to welcome the following new members and re-grades:

Hans Agingi	Student	Af	Steven Berry	Graduate Engineer	A
Lucy Alexander	Environmental Consultant	A	Helen Beveridge	Regional Environmental Advisor	M
William Anstey	Consultant	M	Tim Boyle	Environment Protection Officer	M
Heather Barrett-Mold	Consultant	F	Philip Branchflower	Associate – Air Quality	M
			Damian Brosnan	Partner	M
Neal Barton	Graduate	A	James Buck	Scientist	Af
Stacie-Ann Berry	Graduate Geo-environmental Engineer	A	Euan Burford	Principal Environment Consultant	M

David Carpenter	Project Engineer	M
Thomas Cavanagh	Higher Education Course Manager	A
Peter Childs	Associate Director	M
Robin Clarke	Chemist - Trace Organics	M
Emma Clarkson	Senior Environmental Consultant	M
Lucy Cleverley	Environmental Consultant	M
Gareth Clubb	Senior Research Officer	M
Peter Cottrell	Environmental Scientist	A
Michelle Cox	Senior Environmental Scientist	M
Rachel Cutler	Project Air Quality Consultant	A
Patricia Dean	Carer	A
Tracy Dodds	Environmental Consultant	M
Elaine Edmonds	Environmental Scientist	A
Linda Febvre	Lead Environmentalist	M
David Ferguson	Head of Corporate Responsibility Strategy	M
Morgan Fitzpatrick	Senior Consultant	M
Ian Fraser	Senior Environmental Project Engineer	A
Martin Gibson	Sustainable Tourism Project Manager	M
Christopher Goodman	Environmental Advisor	M
Craig Gothard	Environmental Engineer	A
Antony Gough	Principal Environmental Specialist	M
Bradley Hall	Environmental Consultant	M
Colin Harbinson	Director	M
Andrew Harvey	Air Quality Scientist	A
John Harwood	Field Monitoring & Data Officer	A
Suzanne Hodgson	Graduate Air Quality Scientist	A
Claire Holman	Director of Environment & Sustainability	F
Neil Honey	Transportation Planner	M
Avril Johnson	Consultant	M
Nolasco Jove	Assessor	M
Frances Kilmurray	Senior Environmental Consultant	M
Alena Landers	Environmental Engineer	M
Ho Pang Leung	Assistant Environmental Scientist	A
Jonathan Mape	Environmental Scientist	M
Gregory Marshall	Head of Sustainable Development	F
Julius Mattai	Environmental Data Manager	M
Simon McCloskey	Air Quality Consultant	M
Darren McGrath	Associate	A
Emma McLaughlin	Graduate	A
Craig Messingham	Student	Af
Kate Michie	NHBC – Scotland	M
Malgorzata Miler	GIS Technician	Af
Adrian Mill	Environmental Specialist	M
Lucy Millard	Environmental & Sustainability Officer	A
Christopher Moore	Surveyor	Af
John Newlands	Environmental Scientist	A
Julian Ng	Air Traffic Control Officer	Af
Ginika Osuno	Environmental Consultant	A
Nicolette Parham	Project Consultant - Air Quality	A
Maryanne Paterson	Environmental Scientist	M
Janak Pathak	Lab Technician	Af
Bridget Plimmer	Senior Hydrogelogist	M
Gary Powell	Sustainability Advisor	M
Rob Quinn	Environmental Manager	M
Michael Quint	Associate Director	M
Kirsten Rae	Environmental Engineer	A
Ian Ramsbottom	Environmental Scientist	A
Matthew Richard	Student	Af
Laura Ridge	Senior Consultant	M
Niamh Roche	Environmental Consultant	A
Susan Russell	Environmental Consultant	M
Mark Scerri	Environment Protection Officer	M
Kerryn Schrank	Program Director	M
John Shelton	Consultant	A
Kate Simpson	Capita Symonds Ltd	M
Stuart Sneddon	Environmental Consultant	M
Jill Sowerbutts	Environmental Geologist	A
Samuel Starkey	President	Af
Paul Stephenson	Senior Air Quality Specialist	M
Emma Suddick	Postdoctoral researcher	A
Smitha Sukumaran	Recycling Support Officer	M
Tamyra Sullivan	Lead Consultant/Business Manager	M
Caitriona Swords	Regional Manager	M
Chi Tam	Environmental Engineer	M
Adam Thompson	Water Sampling Technician	A
Mary Thompson	Assistant Engineer	A
William Tippett	Retired	Af
Marzhan Tleubayeva	Environmental Compliance Specialist	A
Shyn Tong	Graduate Environmental Scientist	A
Nicola Trought	Senior Air Quality Scientist	M
Tristan Tucker	Environmental Scientist	M
Patricia Tumwine	Graduate Environmental Scientist	A
Benjamin Warren	Air Quality Consultant	A
Mark Williams	Regional Risk Management Director	M
Alexander Wilson	Environmental Engineer	A
Karen Yale	Senior Environmental Scientist	M

KEY:

F = Fellow **M = Member** **A = Associate** **Af = Affiliate**