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How can cities mitigate and adapt to climate change?

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Climate change and cities

Scientific research and many practical projects are showing that global climate change can be partially mitigated if the world's big cities substantially reduce their environmental impact. Consequently, it is only through transformation of their infrastructure, especially transport, and the use of power in their buildings, and in the behaviour and consumption patterns of their residents, that it is possible for the global environment to improve.

The interesting papers in the special issue of *Building Research & Information* special issue (2003, **31**[3–4]) show how this issue is now being addressed seriously by urban planners and architects. Although the solutions are complex, a good deal of consensus is emerging. Comments here are based on my research on climate change (Hunt, 1999) and urban environment, and part-time activities in local and national politics and government. Urban transformations, like climate change, will take tens of years and are probably reliant on significant developments in how cities are governed and planned. Cities have a very direct interest in mitigating environmental change. If no action is taken across the world over the next 20–30 years, research suggests that many aspects of their environment will deteriorate and the life and even viability of cities will be threatened; many cities are on coastal plains which will be subject to more frequent flooding from increased rainfall and sea level rise; the rises in annual temperature of about 4°C in the UK's rural areas and typical peak values in London of 4°C or more *greater* than those in surrounding areas (Graves, Watkins, Westburg & Littlefair, 2001). Such high temperatures combined with episodes of high air pollution that are predicted to occur more frequently after 2010 are likely to cause serious health effects, such as those experienced in Athens in recent years. In developing countries, the most critical environmental issue is the shortage of clean drinking water and sanitation in urban areas with huge and growing populations. Increasing temperatures and the frequency and severity of droughts exacerbate these problems.

Urban areas should be of a particular concern in the follow-up to the World Summit on Sustainable Development held in Johannesburg in August 2002. These actions should build on the many practical programmes and environmental studies of 'Agenda 21', initiated at the United Nations (UN) Conference on Development at Rio de Janeiro in 1992. However, there are also many difficult scientific questions to answer in order to develop the most cost-effective measures especially in situations where the environment is deteriorating rapidly whether from human activities or natural causes.

In the environmental field, much of the applied scientific and engineering research is concerned with urgent current questions of policy and practical measures. However, studies with broader and historical perspectives are also equally necessary for making predictions about how society might respond to future developments, and for establishing the most effective policies for urban communities. Some constructive ideas about these issues are emerging from research in almost every academic discipline; not only the obvious ones of biology, architecture, geography and economics, but also physics, engineering, medicine, archaeology, political science and others.

Interdisciplinary research in technology and social science is leading to new ways of explaining and presenting environmental issues. The need for more effective participation in all levels of urban government was one of the emphatic conclusions of the UN Habitat II Conference held in Istanbul in 1996 (Hunt, 1996). These broad aspirations are now being implemented in different ways by elected and appointed government agencies around the world. The developing world has shown the way in Brazil. The experiences of South Africa in an evolving political situation are described by Du Plessis *et al.* (2003).

As the review by Lowe (2003) makes abundantly clear, cities need to adapt to climate change as well as modify their impact on the local and global environment. Because of this interaction, it should be possible to combine scientific, political and economic initiatives for the mitigation of climate change and also adaptation to it as it occurs. Understanding the dismal consequences of doing nothing has to be combined with visions of the benefits of constructive change. Science and technology play a key role in both aspects. The ongoing studies of the Intergovernmental Panel on Climate Change (2001) are indicating how the global temperature and seal level are rising, with the likely consequence of further but as

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yet not quantified climate consequences such as storminess, permafrost melting, desertification, floods and drought. It is probably too late for these effects to be prevented, but action over the next 50 years should, as the UK Royal Commission on Environmental Pollution (2000) stated, reduce the likelihood of large urban areas of the world becoming uninhabitable – which is a real long-term possibility. The greatest threat to urban areas arises in countries that already suffer from regularly occurring natural disasters. Some countries, like Norway, Iceland and New Zealand are developed (Lisø *et al.*, 2003), but most are developing. Nevertheless, in geophysically quiescent countries like the UK, the threats are sufficiently real that government, civil society and the private sector are trying new approaches and realising that future patterns of urban life will indeed be different.

Lessons from London

London has had a relatively benign environmental history. It has not experienced the overwhelming natural disasters that some other cities have suffered, such as the disappearance of its river or of large earthquakes. However, major flooding (which can come from upstream tributaries or from surges in sea level driven by storms) along the Thames have meant that its buildings and river structures (as archaeological excavations have revealed) have been substantially affected by past variations in climate and sea level. Both the real and perceived risk of flooding has increased. Consequently, London is dealing with this danger rather more proactively today. There are detailed plans to raise permanent flood defences against future climate change effects, which, nevertheless, recognize that people want to live in flood-prone areas and that they need to understand and prepare for the associated risks (Evans et al. 2003).

Urban societies are keenly aware that they live in an uncertain and dangerous environment. Whether from deliberate mayhem, accidents or natural events, London has experienced riots and tensions over the centuries and cataclysmic events such as the Plague (1665), the Great Fire (1666) and storms (e.g. 1703) and the fatal degradation of the quality of air and river water in 19th century. Recent research on health and society continues to show that there are large variations in community health in London and that these are probably associated with environmental inequality, which is mainly determined by air pollution and differing levels of occupational risk. Environmental health is likely be an important cause of future political tensions, as already is the case in some developing countries. A recent government report (Department of Health, 2001) on the health effects of climate change pointed to the possibility of intercommunity tensions in the UK when, as is expected over the next 50–100 years, the coastline moves inland and substantial numbers of people are displaced into existing or new areas of housing. This is one of the social aspects of the current Foresight Project on Flooding and Sea Level Rise being run by the UK Government Office of Science and Technology.

The worst aspect of London's environment has always been air pollution, causing a Royal decree against coal smoke in the 13th century. In the 1850s, parliamentarians complained in summer months that they could not stand the putrefying odours from the untreated sewage in the Thames, and in 1952 London suffered its greatest 'smog' when more than 3500 people died in a few days mainly from lung damage caused by sulphur dioxide and smoke particles (WHO, 1961). By contrast, the greatest air pollution threat nowadays derives from low-level chemical constituents in the atmosphere produced by car exhausts and their interactions with the atmosphere and solar radiation – as scientists in Los Angeles first explained in the 1940s. The epidemiological evidence of the harm of these chemicals came later – amounting to about 24 000 premature deaths in the UK's urban areas each year. Through computer modelling and street-side monitoring of up to 20 different types of gases and particles, the London-wide Air Pollution Research Group has shown how quite unlike the old smog, the concentrations of these pollutants vary greatly from one street to another, according to variations in the intensity of traffic. Car exhausts are emitted at low level into the atmosphere, so that the highest concentrations of pollution are within the street. Computer predictions and real-time monitoring of pollution are now made so that traffic can be controlled so as to reduce the build up of pollution in critical areas, or to advise pedestrians and cyclists/motorists where air quality is least harmful. Leicester has already implemented a sophisticated traffic control system to ensure low levels of pollution concentration. New technologies of hybrid gasoline–electric cars (which reduce emissions–by 50%–associated with accelerating and braking) and hydrogen fuel-cell cars will substantially reduce air pollutants and carbon dioxide emissions, as automobile executives at a recent Anglo-Japanese forum explained (2003).

Other related areas of research on urban environmental hotspots include studying the effects of excluding traffic from central areas. At the European-wide scale, there are agreed 'targets' for the reduction of the background levels in the lower atmosphere of nitrogen monoxide, ozone and, perhaps soon, small particles. More comprehensive monitoring of the changes in concentration of these constituents is increasingly being performed by the new generation of satellite instruments. Success in these policies will lead to significantly reduced frequency of episodes of poor air quality in the UK cities triggered by air pollutants drifting in from the Continent. The UK Climate Impact Programme has pointed out that higher concentrations of air pollutants are more likely with climate change-induced anticyclone weather patterns. In combination with higher temperatures associated with global warming, the health effects are even more serious. What Athens experienced a few years ago, France experienced in 2003. London may be next.

Technological changes continue to influence London's environment. London is now a sprawling community, ingesting globally sourced energy and raw materials, and also exporting its services and much of its waste globally. According to current mathematical models of city growth such as those of European project SATURN, this pattern will continue. This prediction is consistent with the view that the driving force of big city businesses is essentially 'piratical' (Glancey, 2000). However, even the most dynamic city economies require consensus and coordination as the Victorians were forced to accept 150 years ago. The same lessons apply today.

Some lessons are being applied today to the production of solid waste. Pollution control, planning and technology are all essential for finding new solutions to the growing problems of reducing transporting and disposing the 10 million tons per year of London. Alternatives (which the European Union has declared mandatory) to the current landfill and incineration disposal methods are being sought by motivating industries to develop profitable waste recycling technologies, and by applying the biochemical science and engineering research underway at many universities (Hertin, *et al.* 2003; Mills, 2003).

Liquid waste is managed better. The large reservoirs and pumping stations that provide the drinking water and deal with the liquid waste of Londoners are also well-known ecological amenities amid fine examples of industrial architecture. Water consumption is increasing as a result of population expansion and 'lifestyle' changes. To meet this demand, more of London's drinking water comes from rivers, some of which is recycled through humans and treatment plants several times. Research into these processes in changing environmental and social conditions are being undertaken to understand, for example, how the effect of climate change affects the rate of microbiological processes, while the increasing volume of new pollutants such as medicines, oestrogen and other hormones that may not be destroyed in the treatment plants are in danger of affecting human health.

The capital's reservoirs along with the other major open spaces including London's parks have a critical role in London's ecology. Particularly important questions are why certain species are disappearing, notably sparrows, and how the ecological chain along the rivers and in the Thames Estuary will evolve as the sea level rises and massive new structures are introduced, such as a new Thames Barrier. Nevertheless, as the Natural History Museum has shown, London, like other cities, is a region where there is a greater intensity of biodiversity than the surrounding rural–agricultural areas (Henderson, 2003). However, vigilance is certainly required by many groups to monitor this situation as the climate and environmental change.

The effects of these changes will involve many interacting processes; the damaging combination of high temperatures and atmospheric pollution has been mentioned; a sea level rise may force more people and industry into protected urban areas, thus further exacerbating these trends.

Research, policy and action

So how should urban communities respond to these potential threats to their future sustainability? One strategy is to act immediately to prevent the symptoms worsening, and therefore before all the ramifications of the problems and possible solutions can be studied and understood, as the special issue has emphasized.

Although this 'precautionary' approach may be necessary for urgent problems (as with the congestion charges aimed to reduce traffic in Central London from February 2003), it is steadily being replaced by more deliberate and scientifically based planning, which is possible given the long time scales of urban planning, and by changes to the regulations and practice of architecture and construction. Working on this measured time scale should avert some of the costly mistakes and unacceptable changes in urban infrastructure that occurred with some projects in the 1960s and 1970s. Since progressively more aspects of the urban environment, including social aspects, are being systematically monitored and modelled, future scenarios and plans can be based on more reliable predictions. Both the UK government and international agencies use these data to provide objective goals for the environment and implementation policies. For example, following the Environment Act 1995, UK cities, after detailed measurements, use computer modelling and consultation with their local groups (which, for example, in York now involve quite elaborate comparison between perceived and objective data on air quality) to decide on local action plans for reducing air pollution.

Reaching the goal of sustainable development inevitably involves all the main activities of an urban area. Therefore, any successful strategy must weave together all the specific plans and relate them to ongoing actions. At a conceptual level, this requires collaboration not only between many academic disciplines, but also between professional skills, managerial initiatives and financial resources. Experience shows that a considerable leap of faith is needed to start the exercise.

One of the next steps has been to establish realistic and specific targets and measures of progress towards sustainability, so that organizations and localities can contribute meaningfully to meeting current deficiencies.

In small, urban communities, many remarkable initiatives to create more sustainable housing, energy and transport systems are underway, a notable example being that of Woking, just outside London, where the borough's pollution from energy use has been reduced by about 40% by applying combined heat and power, renewable power with photovoltaic systems, and hydrogen cells, which also produce useful supplies of clean water. If city electricity consumers choose to use renewable electricity, they will help to reduce greenhouse gas emissions, but they are not doing so at present. However, the UK government is supporting local initiatives and is also revising the current rather conservative building regulations (Hansard, 2003). These have to be changed if architects and planners are to be allowed legally to construct the low-energy buildings that cities need to be sustainable (Lisø *et al.*, 2003; Sanders and Phillips, 2003).

There is no doubt that human activities in the cities of the world affect the global environment and are at risk from the effects of climate change. However, by applying technology to building design and transportation systems, there is the real possibility that the energy use of cities could be reduced close to the 50% level necessary to moderate global warming significantly. Even in an ideal world of total consensus on climate change policy, this action is not sufficient and significant adaptation policies are also necessary. Through appropriate urban planning, especially green spaces and, again, building design, together with appropriate risk management, cities have methods for adapting to the effects of climate change and for moderating some of its worst effects on their populations. Creating sustainable cities is an enormous challenge for everyone and at every level and every facet of our complex societies! Such changes to urban societies are only conceivable in democratic societies if there is huge political, educational and economic commitment. Even in the small island societies that are most under threat from climate change, their societal transformations are occurring very slowly. One can only speculate about how long the transformations will take in the less geophysically dangerous areas of the world, such as Europe, America and Japan.

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