

Eco-cities special: Ecopolis now

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Fred Pearce

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A HUNDRED years ago, the largest city in the world was London, with a population of 6.5 million. Today it is dwarfed by Tokyo. With barely a quarter the population of London a century ago, Japan's capital city has since mushroomed to 34 million, propelling it to pole position in the global city league table.

Tokyo's phenomenal growth is largely down to a single factor: migration from the countryside to the city. It is just one of many to have overtaken London, which with a population of 7.5 million today doesn't even make the top 20.

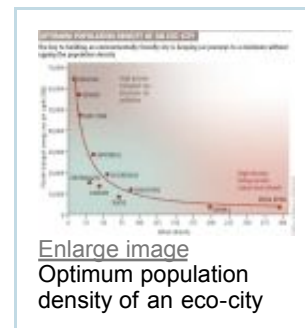
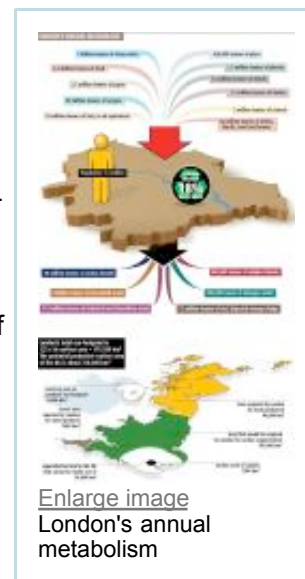
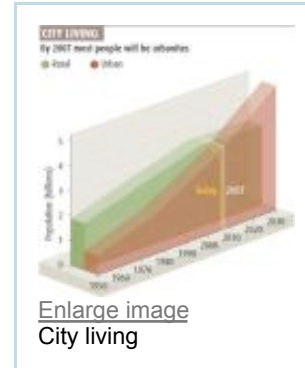
This rural to urban migration can now be seen in scores of cities across the globe. And it has brought us to a pivotal moment in human history. In 1900, most people lived in the countryside, with a little over 10 per cent of the world's population living in cities. From next year, the UN Population Division predicts that for the first time in history, more people will live in cities than in the country (see Graph), and the biggest growth will be in "megacities", with populations over 10 million.

The meteoric growth of megacities - there are now 20 in total (see Map) - has brought with it huge environmental and social problems. Cities occupy just 2 per cent of the land surface of the Earth but consume three-quarters of the resources that are used up each year, expelling the half-digested remains in clouds of greenhouse gases, billions of tonnes of solid waste and rivers of toxic effluent. Their inhabitants are making ruinous demands on soils and water supplies for food, and on forests for timber and paper. For example, London needs 125 times its own area to provide the resources it consumes (see "London's annual metabolism"), and if the new megacities in the developing world are allowed to grow in the same way that cities did in the west, their environmental impact will be catastrophic.

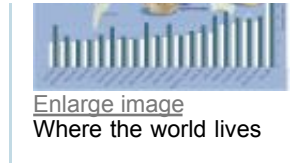
Scientists calculate that a sustainable ecological footprint that shares all the world's resources equally among its inhabitants would be 1.8 hectares per person. Today, the average in rural China is 1.6, in Shanghai it is already 7, and the eco-footprint of a typical American is 9.7.

Returning the world's population to the countryside isn't an option. Modern living standards mean there is little difference between the eco-footprints of rural and urban dwellers. And dividing up the planet into plots of land on which we could all live self-sufficiently would create its own natural disasters, not to mention being highly unlikely to ever happen.

If we are to protect what is left of nature, and meet the demand to improve the quality of living for the world's developing nations, a new form of city living is the only option. The size of a city creates economies of scale for things such as energy generation, recycling and public



transport. It should even be possible for cities to partly feed themselves (see "Urban appetite"). Far from being parasites on the world, cities could hold the key to sustainable living for the world's booming population - if they are built right.



Fortunately, governments, planners, architects and engineers are beginning to wake up to this idea, and are dreaming up new ways to green the megacities. Their approaches rest on two main principles: recycle whatever possible, and cut car use to a minimum. So as well as developing energy-efficient buildings, emphasis is being placed on increasing the use of public transport and redesigning how cities are organised to integrate work and living areas into a single neighbourhood, rather than separating cities into residential, commercial and industrial zones.

The big ideas are still on the drawing board, but many cities already have showcase eco-projects. For example, at the new A\$50 million (\$40 million) home of Melbourne city council in Australia, hanging gardens and water fountains cool the air, wind turbines and solar cells generate up to 85 per cent of the electricity used in the building, and rooftop rainwater collectors supply 70 per cent of its water needs. In Berlin, Germany's new Reichstag parliament building cut its carbon dioxide emissions by 94 per cent by burning carbon-neutral vegetable oil. In San Diego, California, refuse trucks run on methane extracted from the landfills they deliver to. In Austria, 1500 free bicycles have been distributed across Vienna. Reykjavik in Iceland is among the pioneers of hydrogen-powered public transport, and Shanghai is subsidising the installation of 100,000 rooftop solar panels. The Chinese city is also about to put many of these ideas to the test by creating the first purpose-built eco-city from scratch (see "Master plan").

Unfortunately, for the past century most cities have been moving in the wrong direction. Planners have designed cities as if resources such as land, fuel and concrete were unlimited, and waste has been something to dump as cheaply and as distantly as possible. Worse, they designed cities around cars rather than people. Heading the field in this respect has been the US, where the architect Frank Lloyd Wright provided a blueprint for modern America in his "Broadacre City", a suburban idyll of homesteads connected by an endless lattice of highways. The model became a global template, stretching from Milton Keynes in the UK to Brasilia, the modernist new capital that Brazil built in the middle of its central savannah in the late 1950s.

This generation of city builders "worshipped at the altar of the automotive god, and idealised mobility and freedom", says Peter Hall, professor of planning and regeneration at University College London. They thought that community living was over and that in the future people would have no desire for local neighbourhood. This idea was embraced in the 1960s by one of the most influential figures in urban planning, Christopher Alexander, professor of architecture at the University of California, Berkeley, who said that when your friends don't live next door, neighbourhoods became not just irrelevant but stifling "military encampments designed to create discipline and rigidity".

The problem with this kind of thinking is that the resulting cities lack the flexibility that would allow them to respond to the wishes of their inhabitants. They just don't work.

As a result, Alexander's philosophy has turned many cities, especially in the US, into social and ecological disaster areas, teeming with socially deprived neighbourhoods whose inhabitants are forced to rely on the polluting, petrol-guzzling car to maintain the illusion of freedom. Cities have never grown in the way that urban planners imagined, says Michael Batty of University College London, which is why the grand plans are rarely successful. The best that planners can hope for is to intervene at decisive points and let human nature and market forces do the rest.

Planners and architects now agree that to improve the social and environmental condition of cities the top priority is to cut car use. They say zero-emission cars running on electricity or burning hydrogen are not enough. "Automobiles still require massive networks of streets, freeways and parking structures to serve congested cities and far-flung suburbs," says Richard Register, founder of the non-profit campaigning organisation EcoCity Builders in Oakland, California.

What is needed is a wholesale rethink of how new cities are laid out - and how existing ones

expand - to minimise the need for cars in the first place. One way of achieving this is to build cities with multiple centres where people live close to their work in high-rise blocks that are also near public transport hubs. In parts of the world this is already taking shape (see "How big can cities get?"). That won't wash with some planners, for whom living in high-rise blocks is at odds with their vision of living in harmony with nature. People need day-to-day access to green spaces and nature to be happy and healthy, they argue. So is there an inevitable conflict between eco-efficiency and pleasant living?

A study by Peter Newman and Jeff Kenworthy suggests not. They found a strong inverse relationship between urban density and the amount of energy used by cars driving within the city limits (see Graph). However, they also showed that super-dense is not a good thing either. Energy use in transport is far higher in a sprawling city such as Houston than in more compact, low-rise cities such as London or Copenhagen, but up the density any more and you run into another problem. Dense cities heat the air around them. Stone, concrete and asphalt absorb more solar energy, and reflect less, than natural surfaces such as grass, water and trees, so they pump up the temperature at night. Vehicles, air conditioning and electrical appliances also give off heat, while tall buildings cut down winds that can disperse the heat. So cities are usually about 1 °C warmer than the surrounding countryside during the day, and can be up to 6 °C warmer at night.

The denser the city, the worse the effect. In hot climates, where many of the world's super-dense megacities are found, air conditioning is used to keep the indoor temperature bearable. On a hot day in many of these cities, air conditioning can consume more energy than any other single activity.

To cut this huge use of energy, many cities are taking steps to counter the heat-island effect by redesigning buildings to reduce direct sunlight through windows, increase ventilation, cool the air with water fountains and cut energy absorption by painting external walls white. Planting trees along the streets can help reduce the air temperature too. Up to 400 litres of water can evaporate from a single tree every day, cooling the surrounding air. In Miami, researchers found that summer electricity bills were around 10 per cent lower in neighbourhoods with more than 20 per cent tree cover than in neighbourhoods with none.

While planners look at how to cut back the energy consumption of big cities, at the other end of the scale are shanty towns - organically evolved and self-built by millions of people in the developing world without a planner in sight. These shanties meet many of the ideals of eco-city designers. They are high-density but low-rise; their lanes and alleys are largely pedestrianised; and many of their inhabitants recycle waste materials from the wider city.

From a purely ecological perspective, shanties and their inhabitants are a good example of the new, green urban metabolism. Despite their sanitary and security failings, they often have a social vibrancy and ecological systems that get lost in most planned urban environments.

So perhaps something can be taken from the chaos and decentralised spontaneity embodied in shanties, and combined with the planned infrastructure of a designed eco-city. Cities built without extensive high-rise can still be dense enough to make life without a car profitable, and they can retain the economies of scale needed for the new metabolism built around efficient recycling of everything from sewage to sandwich wrappers. At the same time, they need to remain flexible enough for people to adapt them to the way they want to live. The key is to put people and ecology joint first.

Urban appetite

With a little creative thinking, cities can feed themselves

Feeding a city is no mean feat. Londoners, for example, consume 8000 tonnes of food a day, much of it freshly produced or harvested. In past centuries, cities kept large areas of land close at hand to supply fresh vegetables. In London it was the lower Lea valley, which is now being transformed to host the 2012 Olympics. Today, London imports 80 per cent of its food from overseas, such as apples from New Zealand, vegetables from Africa and meat from Brazil. The same is true in many other cities.

This has provoked a backlash. Many consumers in rich countries see the air miles travelled by their daily bread as a growing scandal - a typical meal travels 3000 kilometres from farm to fork - and want a return to local produce. Meanwhile, in poor countries, fast-growing megacities with crumbling infrastructure and feeble governments are often incapable of organising the food imports they need.

The result is an emerging worldwide trend towards urban farming. Unable or unwilling to rely on distant sources for food, many cities are substantially feeding themselves in a way never dreamed of by the planners. Urban agriculture is a staple activity of most cities of the developing world. According to UN data, around 15 per cent of the world's food is now grown in urban areas, a figure that continues to rise.

Almost a billion city-dwellers around the world, a third of the total, spend some time each week tending plants to help feed their family or to sell in local markets. The high demand from fast-growing urban populations means that these urban farmers can make bigger profits than their country cousins, and will invest in novel systems for maximising yields on their tiny plots.

In Kolkata in India, 20,000 people farm the richly composted old waste dumps and raise carp in tanks filled with the city's sewage effluent. In Lima, Peru, they raise guinea-pig meat in squatter settlements, while in Nairobi, Kenya, chickens fatten in coops bolted to apartment walls. In Haiti people grow vegetables in old truck tyres. The Bosnian capital of Sarajevo survived the siege in the early 1990s by cultivating its wasteland. Even in the UK, city dwellers grow vegetables and fruit on 300,000 urban allotments.

In the booming Chinese megacity of Shanghai, about a third of the land within the city limits is still used for agriculture, and almost a million of its inhabitants still work on the land. The city produces virtually all its own milk and eggs and most of its own vegetables, as well as much of its meat and 2 million tonnes of grain a year. "Prices are high because of the big market, so farmers can get rich," says Xinming Bian of the Nanjing Agricultural University. "People move from other parts of China to work there."

Novel farming systems gaining ground include hydroponics, in which roots are suspended in a liquid growing medium that provides the plant with nutrients. The technique is popular in Singapore, Bogotá in Colombia and Montreal in Canada. Because there is no need for soil, it is also being rapidly adopted in rooftop gardens.

Farming in the city brings other benefits, including access to an abundant supply of free fertiliser in the form of human sewage. The distribution of night soil by bucket - once a fixture of urban life from Paris to Beijing - is rare now. However, according to Chris Scott of the Sri Lanka-based International Water Management Institute, some 10 per cent of the world's irrigated food crops are simultaneously irrigated and fertilised by the smelly stuff coming out of city sewer pipes. Far from banning the practice or ignoring it, he says governments should take advantage of it and make it safe by treating sewage to remove pathogens while leaving the nutrients.

Eco-cities must be farming cities, says Jac Smit, president of The Urban Agriculture Network run by the UN Development Programme. "Urban farming creates green spaces, recycles waste, cuts down on freight transport, prevents soil erosion and is good for the microclimate."

How big can cities get?

Get ready for a century of urban sprawl

The rise of the megacity - usually defined as having a population of more than 10 million - is one of the most extraordinary phenomena of the modern world. New York City was the first to reach megacity status, sometime around 1940. Today there are at least 20, including three in India and two in China.

There does seem to be a practical limit to the size of a city with a single downtown. In recent years, a succession of megacities have surged through 10, 12 and 15 million inhabitants

before seizing up with traffic congestion and choking with pollution. People and business have fled, taking with them the wealth that made the cities what they were. Against all expectations, these megacities have abruptly stopped growing.

Mexico City is a typical case in point. Its population soared to 16 million people in the mid-1980s and was predicted to double by 2000. Instead, it is stuck at 18 million. Likewise, São Paulo in Brazil hit a wall at 18 million, and Kolkata in India, once predicted to reach 40 million people, is stable at 13 million.

Something new is happening. Single megacities are being replaced by urban archipelagos, only some of which have a dominant megacity at their heart. Helped along by the boom in cheap communications, extensive transport networks and cultural changes in work and living, they have become "the largest, most complex man-made structures ever created", says Herbert Girardet, professor of environmental planning at Middlesex University, London.

For example, London's population count may have reached a plateau, but it is spawning a sprawling urban region covering most of the south-east of England. The original city is now flanked by urban centres west towards Reading and Oxford, north towards Cambridge, and, as the government plans it, east along the Thames estuary. Likewise, the people of Mexico City fled to Toluca and Cuernavaca; Kolkata dispersed to a rash of new urban centres across West Bengal; São Paulo is embracing a new "golden urban triangle" stretching to Rio de Janeiro and Belo Horizonte; Hong Kong is merging with Chinese urban centres round the Pearl river delta; and 70 million people are linked by bullet train from Tokyo to Osaka. This last is the largest and densest megalopolis of them all.

A 200-kilometre journey west along the banks of the Yangtze takes you from Shanghai to Nanjing, through a largely built-up hinterland. Suzhou, one of the cities on that route, is a metropolis of 5 million people constructed in 15 years on the model of Singapore, which it has now overtaken in size. Heading south-west from Shanghai by 2010 it will be possible to travel the 170 kilometres to Hangzhou in just 27 minutes aboard a new maglev train, uniting a crescent-shaped urban corridor containing some 75 million people. Right now, the Yangtze delta is the fastest growing urban area in the world.

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