mace

INSIGHTS

02

TOMORROW'S CITIES

Urbanisation changing the way we live

Jason Millett

COO for Major Programmes & Infrastructure

Jason is responsible for Major Programmes and Infrastructure (MP&I) and is driving our goal to be the UK's leading programme manager by 2020. He has over 20 years' industry experience and leads on some of the UK's most significant projects alongside the largest global programmes. Under his leadership, MP&I has seen 43% growth over the last three years. He was CLM's programme director for the London 2012 Olympic and Paralympic Games, responsible for the delivery of the Games venues and the commercial closure of the most successful Olympics ever.

Prior to joining Mace he was CEO of Bovis Lend Lease while also holding the role of CEO of Catalyst Lend Lease.

Jason is an advisor to the Mayor's London Infrastructure Delivery Board, a fellow of the Chartered Institute of Building and the Association of Project Management.

Stefano Saldini

Strategic Planning Director

Stefano is responsible for providing strategic advice on the delivery of large and complex capital investment projects and programmes in the various sectors of transport, energy, sport, water and urban development.

Stefano played a significant part in London's winning bid to host the 2012 Olympic Games and in setting up the key strategies for the delivery of the Olympic Park. He worked on a number of international programmes including the 2014 Winter Olympic in Sochi (Russia), Mecca's (KSA) transport plan and a free trade zone in Lagos (Nigeria). He has recently led the feasibility study for a new capital City in Egypt, the delivery strategies and plans for two new power plants in the UK as well as the delivery studies for the proposed 3rd runway and terminals at Heathrow Airport.

Prior to joining Mace in 2004 he worked for Arup and Waterman Group on the front end engineering design of major buildings and infrastructure projects. He has a MSc in Civil Engineering and he is a Chartered Engineer both in the UK and Italy.

2010

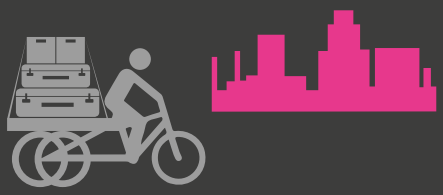
5/10 people lived in an urban area

2050

7/10 people will live in an urban area [i]

70m

people on average, move to cities, each year [ii]



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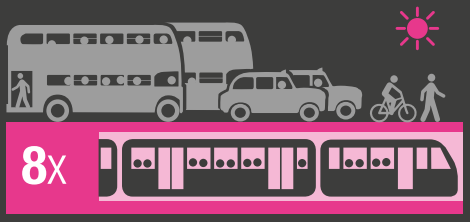


the population of Greater London

220m

more people will move to cities in China by 2030 [iii]

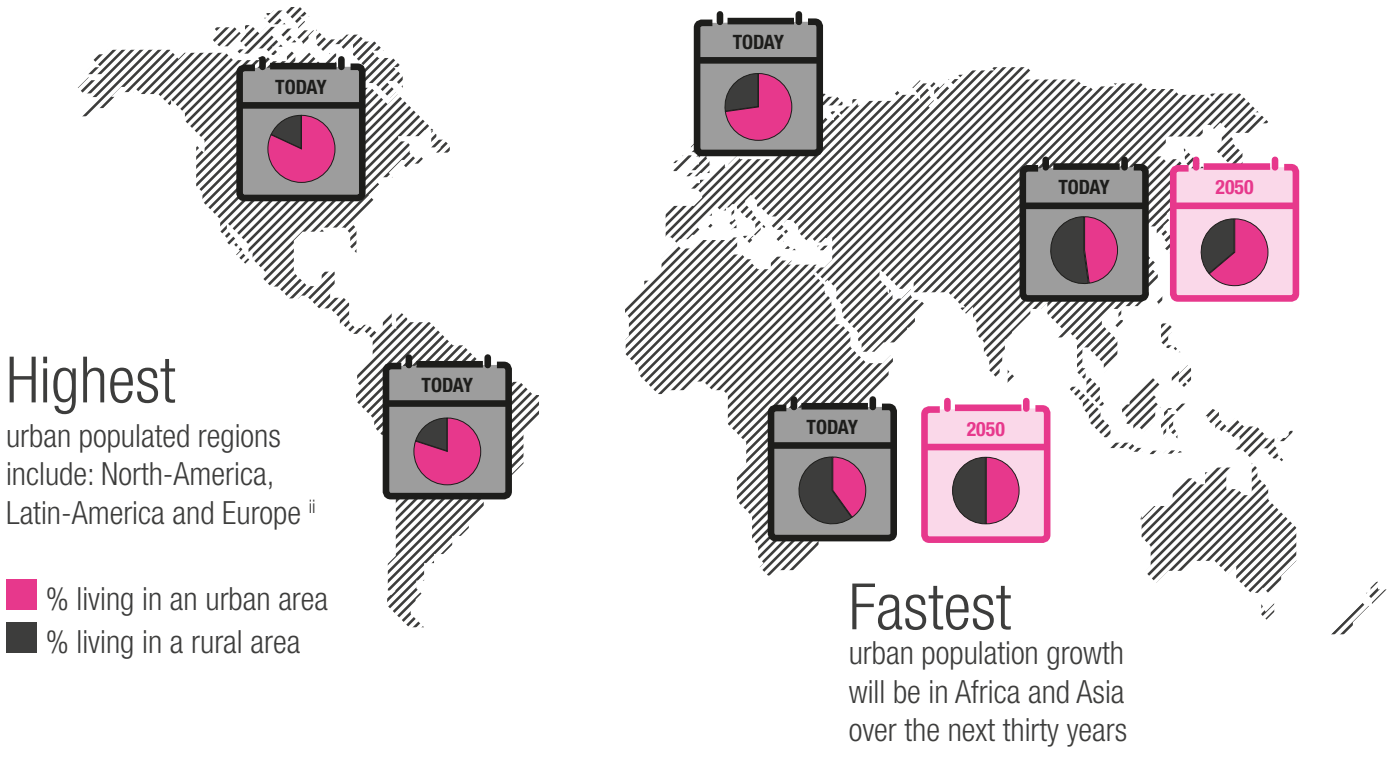
Urban populations are rapidly increasing and cities are playing a critical role in human existence. City regions are more productive, present more opportunities and research has shown a clear positive correlation between urbanisation and wealth. As a consequence more people are choosing to live in cities. The current urbanisation trends show no sign of slowing and the expansion of cities cannot be contained. Urban growth is not only a characteristic of megacities like Shanghai, Lagos or Mumbai with all cities growing at similar rates regardless of their size. In the future, as well as the emergence of new cities, existing ones will be bigger, more connected with some cities forming mega urban clusters with more than 100 million inhabitants.

Urbanisation is happening so fast that the supply of new buildings and infrastructure cannot match demand. With demand outstripping supply, the market is overheating, resulting in a higher cost of living. In many cities, infrastructure is coming to the end of its operational life cycle. In the developing world, informal settlements are springing up rapidly and many large cities are characterised by low accessibility to electricity and clean water, overcrowded and overused public transport, and severe road congestion. Notwithstanding the urbanisation progress experienced by most cities worldwide, not all cities are seeing growth. Some post-industrial cities like Detroit are on a downward trend and facing issues such as shrinking populations, economic recession, oversupply of buildings and underused infrastructure.

In many cases, this growth brings about a range of interwoven challenges, including:

- social pressures due to migration and increased inequality
- a fast changing climate and worsening environmental conditions especially water and air pollution
- reduced natural resources and loss of bio-diversity
- land scarcity and constrained funding.

Urbanisation also speeds up the pace of life while increasing consumption – triggering even more demand for resources. This phenomenon is intensifying, as populations expand and become more connected and wealthy.



INTRODUCTION

However, it is important to remember cities offer many of the potential solutions. The dense nature of cities brings economies of scale in infrastructure and key services. This scale makes it possible to support the business case and fixed costs of infrastructure delivery because they are used and shared among a high number of people. Cities also have long generated new intellectual concepts, in which one smart idea is the catalyst for others. Most solutions will emanate in cities where the intrinsically social nature of urban environments spurs knowledge sharing and innovation.

Solutions which are first created in developed cities, will be adapted and implemented in less developed cities around the world. But that doesn't mean that emerging cities don't have a part to play, they will continue to pioneer ingenious low-cost solutions that will in return be applied to more developed markets.

The main challenge in the decades to come will be how cities can continue to satisfy modern requirements and living standards, whilst remaining affordable. This will need to be achieved while being sensitive to the earth's limited supply of natural resources and ecosystem.

The top 600 cities generate...

60%

global GDP

yet only hold...

20%

global population [iv]

Just three countries are expected to account for...

37%

of the world's urban population growth (between 2014–2050) [i]

NIGERIA

+**212**m

INDIA

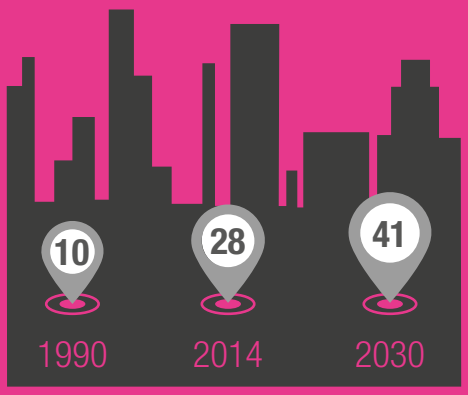
+**404**m

CHINA

+**292**m

WHAT SOLUTIONS FOR THE FUTURE?

The growth of megacities: [i]
(a city with a population of over 10m)



1/8

of the urban population live in megacities today [i]

1bn
people live in slums today

Without radical changes by 2050 there may be...

3.5bn
slum dwellers out of a total urban population of 6bn [v]

Evolving trends
Advances in technology are already changing the way we live – a trend that will only accelerate in the coming decades. Traditional stereotypes about how we work and the boundaries between organisations, sectors and industries are already blurring. A new model of working, supported by emerging technology, could in time recreate the collaborative experience of the workplace, whilst reducing the need to physically commute to work.

Sectors such as retail will transform. We are already seeing the growth of on-line shopping change the way we use physical retail space. Stores are having to reinvent themselves to stay current by transforming into design and co-creation hubs with cutting edge in-store technology and expert advice on tap, to attract increasingly savvy customers.

Conservation policies aimed at reducing the use of natural resources will alter personal consumption. They will likely result in smaller dwellings being built, but at a higher density. And limits on water use, less cooling in warm seasons and possibly more limited food choices. It is likely that we will continue to see the rise of the sharing economy, which drastically improves efficiency whilst using less resources.

The growth of alternative working models, new methods of communication, and smart mobility will also provide the opportunity to develop multi-centric city regions and release the pressure on overcrowded urban areas.

The increasing density of cities and the introduction of new functions in cities' suburbs will also help transform these neighbourhoods and mitigate the gravitational pull of urban centres.

Urban land use will be more productive and multi-functional through emerging technologies such as, water recycling, carbon harvesting, and food production. Existing buildings will be retrofitted to meet emerging requirements (e.g. to increase resilience) while new buildings will be designed to be more flexible and adaptable to future needs and uses. New multi-function hybrid spaces, located near transport hubs, will also become the norm. This will be a critical factor in shifting people's behaviours from private car use to public transport and car sharing, particularly in many already congested cities.

Some cities will continue to decline and will likely go through a process to return areas within them back to nature.

The boundaries between the public and private sectors will blur, potentially resulting in more private sector involvement in the development and management of cities. However, the rise of so called 'i-democracy' will mean the public will have a greater role in guiding and influencing public policies and government services. Community participation, collaboration and knowledge transfer will be critical as new solutions and approaches will need to leverage the experience of other people in other cities to be most effective.

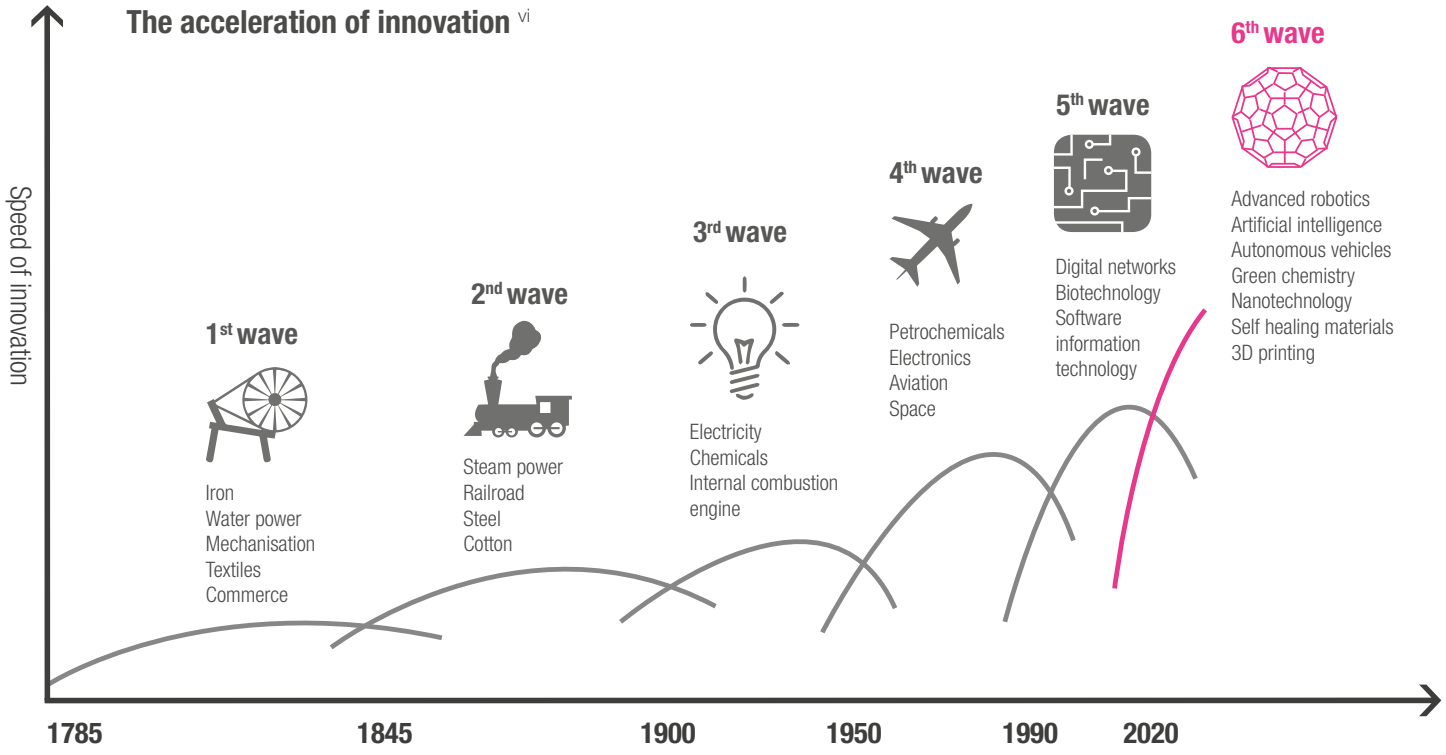
Technological Efficiency
The accelerating rate of technological change will profoundly impact the way we develop and run the cities of the future. Through technology we will have a more accurate understanding of human behaviour. Which will allow to us to plan and operate cities and infrastructure more efficiently, and more responsively to meet people's needs. For example by smoothing travel peaks and troughs. The development of new city models will allow local and central government to quickly assess scenarios and optimise land use, infrastructure requirements and resource consumption. This will be achieved by linking traffic, utilities and social network data, population census, land uses, prices and residential transactions.

Advances in aerial photography and satellite imagery will allow us to make more detailed maps quicker. Emerging technologies will improve the monitoring of city assets, with live data enabling us to quantify and define the extent that the asset is ageing and its remaining design life. This will help to improve resilience and reduce the risk of failure.

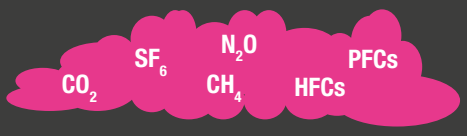
We will be able to analyse entire water eco-systems, from rivers and reservoirs to the pumps and pipes though smart monitoring technologies. This will give water authorities, individuals and businesses real time information about water consumption, helping to raise awareness of usage rates, track down inefficiencies and reduce unnecessary demand.

'Water footprints' (the entire amount of water embodied in cities), will help cities consider a more far-reaching approach to water planning and management, as well as urban development.

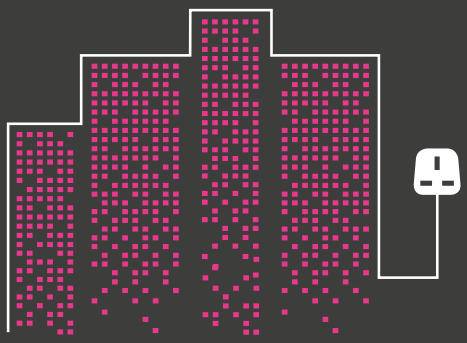
Intelligent technologies will transform energy systems by better coordinating energy distribution in cities. This coordination will bring smart grids and buildings together to help reduce energy loads. The development of grid-scale batteries will allow us to more effectively match electricity output to demand, making decentralised renewable solutions a far more attractive energy option. New building systems will be intelligent by learning from users. They will be able to optimise temperature patterns over time; matching heating and cooling to people's needs as opposed to places.



80%
of global greenhouse gases are produced by cities [vii]

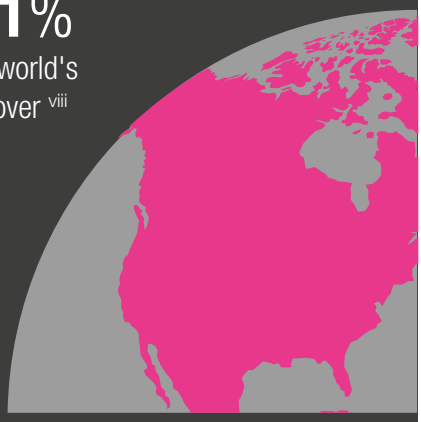


75%
of the world's energy is consumed by cities [vii]



Yet urban land makes up

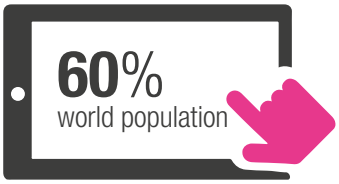
<1%
of the world's land cover [viii]



Driverless buses and trains will enable more efficient and frequent services as routes will be managed in real time based on actual passenger demand. As our recent paper on driverless cars noted, autonomous cars will see a decline in car ownerships, with an increasing use of on request car services, which will increase efficiency, improve air quality, and reduce the need for parking. The vehicles batteries could also act as energy storage for a more integrated and interoperable electricity grid.

Many people assume as technology improves, and efficiencies are made, resources required would go down – this does not hold true. The so called 'Jevon paradox' states how technological progress and efficiency gains may actually result in higher levels of consumption. As a consequence, for resource use to fall, progress will need to be married with measures that encourage more considered use of natural resources.

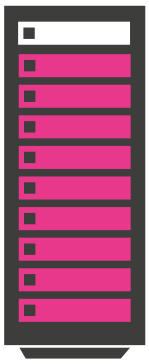
4.7bn
people will be connected to the internet by 2020 [ix]



Every day we create
2.5 quintillion
bytes of data (that's 18 zeros!) [x]

So much that...

90%
of the world's data has been produced in the last two years [xi]



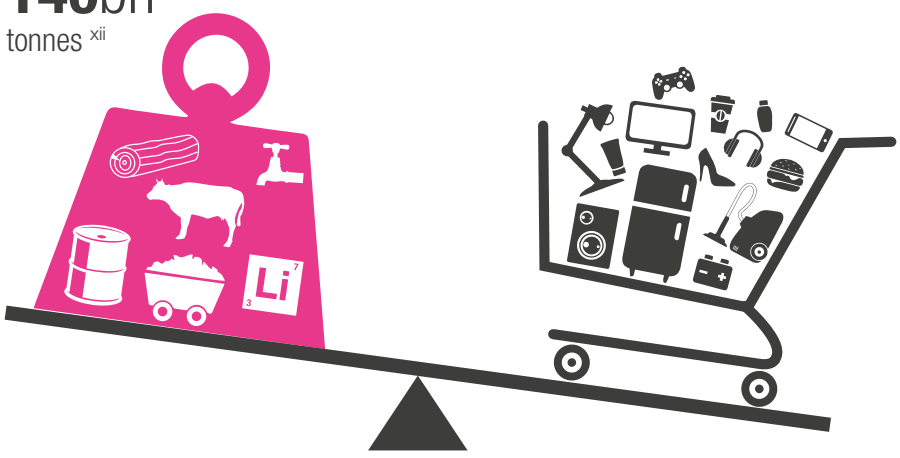
BUILDING MORE WITH LESS

Cities are huge consumers of raw materials. New developments, new housing and the upgrading and maintenance of current assets, mean higher consumption of materials. However, environmental policies, potential supply shortages and market forces will lead us to change how we think about cities. For example, it is now estimated that there is more copper above ground within our man-made structures than remaining in the ground. Similar arguments could be made for high-performance aggregates, aluminium and steel. Keeping track of where these materials are, when it is likely to be released (e.g. via the demolition of redundant assets) and how it can be extracted and recycled is likely to become a key priority for future cities.

Similarly, great savings could be made if more careful consideration was given to recovering the function of materials, rather than recycling the materials themselves. Recovering a complete steel beam for reuse in a new building requires negligible processing and energy consumption when compared to recycling. Thinking more carefully about how we put materials into cities, by designing for easy end-of-life dismantling and reuse of components, could make a huge contribution to reducing carbon emissions and reducing the demand on natural resources. To achieve this, both design and demolition processes will need to change. Design installation will aid end-of-life disassembly while forensic demolition will be favoured over explosive.

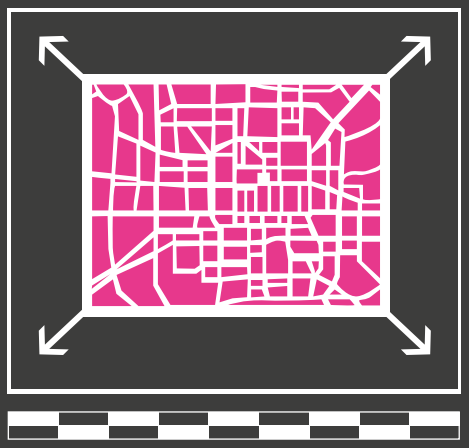
By 2050, if global consumption continues at its current rate, demand for resources will triple to...

140bn
tonnes [xii]



Between 2000 and 2020 (at current expansion rates) urban land cover is doubling to...

1,200,000km^2

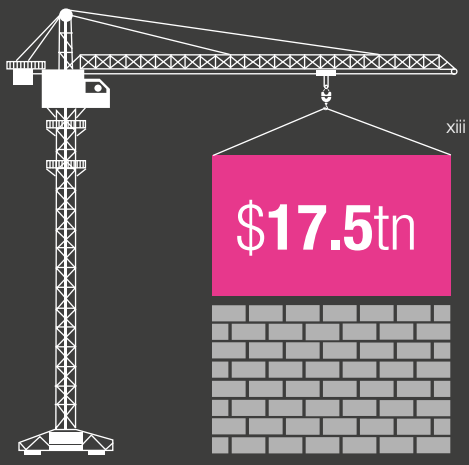


That's equivalent to...

1%

of the world's land area [viii]

By 2030, the global construction market is set to almost double, reaching...



[xiii]

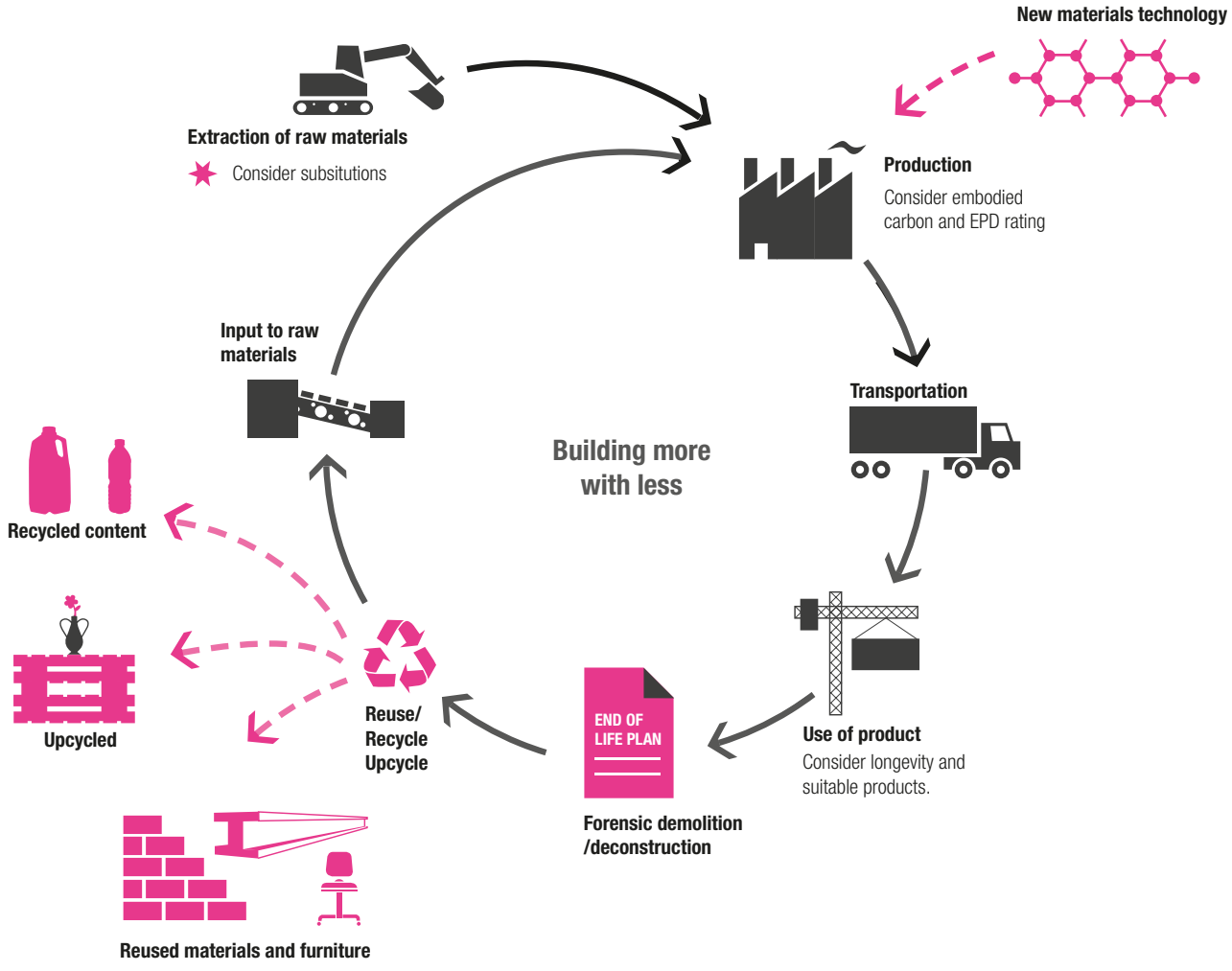
The reuse of structural elements will require advances in asset management so that the initial and residual properties of individual structural elements can be catalogued and archived, allowing easy integration into new structures. It may also require changes in ownership patterns, perhaps where the capacity of a structural element is leased by the building owner for the life of the building rather than owned outright.

New advances in materials technology will improve durability and performance while reducing the consumption of natural resources.

Building materials such as concrete will be able to perform running repairs on itself by fixing small cracks and holes. This increased durability will lead to less maintenance demands.

Roads will have the ability to neutralise harmful pollutants before they contaminate the environment. New insulating materials for cladding or coatings will be critical for reducing heat loss, especially in existing buildings. Up-cycling of waste materials and unwanted products will also help reduce resource consumption and waste.

Many technologies essential for the running of low-carbon infrastructure (e.g. wind turbines) and transport (e.g. electric vehicles) rely on materials that might become harder to source in the coming decades. The major scale of the change in technology will cause a step-change in demand for these critical materials that cannot be met by the current supply chain model. Therefore, a primary aspect of any response must reduce demand through recycling or substitution.



Smart technologies and the increased availability of information will transform the way we plan, design and construct future cities. We will move from individual projects towards a systemic approach (systems, systems of systems and systems of cities). Digital information will offer the ability to evaluate different approaches and solutions, develop complex delivery processes and identify as well as mitigate risks, all within a cloud based ecosystem.

Advanced design and manufacturing will change the way assets are delivered. It will bring economies of scale, higher productivity at reduced costs and foster faster production. While improving quality and material requirement calculations, removing defects and eliminating waste from the outset. For example, 3D printing technologies are being adapted for use by the construction industry and it is envisaged that in the near future, 3D printing will be used to construct buildings and other infrastructure such as pipes and roads.

A new generation of robots will come into commercial use that can move, learn and interact with people and other technology. In the future, we are likely to have a small group of specialists onsite overseeing hundreds of robots and self-driving vehicles.

These machines and robots will interact with the rest of the workforce and produce buildings and infrastructure in a much more precise, higher quality, more cost effective, resource efficient and speedy manner. Robots could also reduce the need for off-site fabrication by bringing fabrication tasks onsite. Robots and drones could also be used to repair street lights, autonomously inspect, diagnose, repair and prevent potholes in roads, and live in utility pipes while performing inspection, repair, metering and reporting tasks.

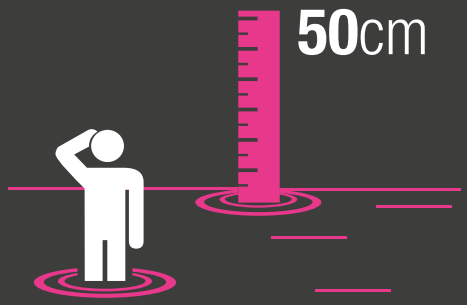
Using geographic information system (GIS) technology, logistics functions will be able to map data on transportation networks, access and pollution restrictions, traffic measures, delivery and transport facilities, districts, population, land use and carbon emissions. Real time data and better analytics are also making it possible to schedule and process decisions that maximise equipment utilisation on construction sites. Deploying data to estimate the probability of failure of specific components (for example trucks, plants) will also help reduce maintenance spending and unplanned interruptions.

In order to innovate at a continually accelerating rate, the construction industry will need to increasingly attract people with a diverse range of skills and experience.

The development and deployment of new technologies will transform the image of construction, which is set to move from being a generally lower skilled, low-tech, labour and resource intensive industry, into a progressive high-tech multi-functional industry that places critical importance on safeguarding the future of the planet and people's wellbeing.

Design and construction companies and asset operators will blur into highly technological organisations, becoming incubators of new solutions and pushing the frontiers of technology. Industry clusters akin to the Silicon Valley model will develop around the world creating a culture of information sharing, helping the creation of new start-ups, stimulating networking and financing of new innovations.

By 2070, if carbon emissions continue unchecked, sea levels could rise...



It is estimated that across just three cities in India,

37m

people will be at the risk of sea level rise by 2070

It is also estimated that New York and Newark will have

$2.1tn

worth of assets exposed to sea level rise by 2070 [xiv]

As the planet continues to heat up, more and more energy is being absorbed by the oceans. As a consequence, much more water evaporates from our oceans, triggering bigger storms and flooding in cities. The approach to flood resilience or rising seas, will be critical as most cities are only slightly above current sea level. This restrains their ability to deal with extreme events such as flooding, storm surges and high winds, which will be at the core of their future resilience strategy. There are already 136 large coastal cities that are now at risk from a rise in sea level. Many developments are still going up with little consideration for future rising waters, making future adaptation harder and more costly. Rising insurance premiums are not sustainable and may affect where people choose live in the future (e.g. on higher grounds) and reduce the value of properties which are more vulnerable.

Building larger and larger barriers to protect cities is also unsustainable. Resilience strategies will need to focus on recovery and getting back to normal quickly after an event, rather than solely preventing events that are unpreventable. This will require a fundamental change in mindset, and the realisation that it is not possible to protect against every natural event, but similarly ensure that critical assets (e.g. power, communications infrastructure, hospitals, main roads, etc.) are safe.

New buildings and infrastructure could be designed to "float" while existing buildings could be retro-fitted to allow their basement or ground-floor level to be flooded, with all below-ground services flood-proofed or raised into new corridors a few meters above the ground. The protection and sanitation of eco-sensitive areas and the creation of natural spaces (e.g. wetlands, tree planting, etc.) will also reduce the impact of extreme events. It will reduce the need for and reliance on "hard" infrastructure solutions as well as boost bio-diversity and contribute to livelihood development (i.e. make nature do the work for free).

Climate change is increasing the amount of droughts. Many future cities will be increasingly face water shortages. Water scarcity, particularly in major urban areas, means that in the coming years people will need to get used to water re-use. Buildings will have to capture and recycle the majority of rainfall and grey water for their own use, or sell surplus processed water to service other city functions. Black water will be treated locally and used as fertilisers, using waste as a resource for landscape and food production. Wastewater technology will greatly reduce area requirements for waste treatments centres whilst maximising the reuse of resources.

The focus on water re-use will not only be for residential and commercial buildings, but also for industrial and agricultural users. As water scarcity can only be tackled by adopting a holistic approach to water use which integrates dwellings, manufacturing, energy and food production.

CONCLUSION

The world is facing enormous challenges to meet the growing needs of a rapidly expanding population. The supply of buildings and infrastructure will need to keep up with demand but do so sustainably and reduced costs.

Cities provide the most effective solution as agglomeration maximises economy of scale in infrastructure and key services by exploiting density and connectivity creating a fertile ground for innovation.

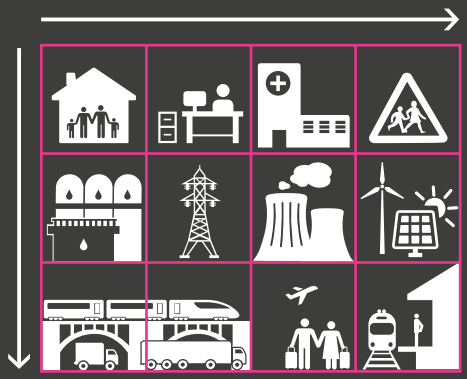
Managing the tension between supply and increased demand will be the main challenge for cities in the coming decades. Too little supply will result in higher cost of living and social pressures. Too much supply will also result in wasteful use of resources. Finding the balance that works for each city will be critical.

Innovation will play a key role in this process as it will change the way we live, work and travel. Technology will make urban land use more productive, transport more efficient, energy more renewable, key infrastructure more resilient and construction less wasteful. However efficiency alone will not be sufficient and it will need to be married with measures that encourage more considered use of natural resources and reduce personal consumption.

To meet urbanisation demands Mace estimates that...

120bn

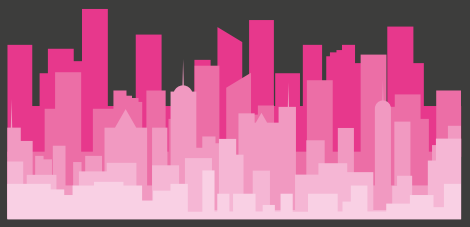
square meters of new floor space and associated infrastructure will be needed 2050 [xiv]



This is equilavent to

30m

buildings...



... And requires capital investment of...

REFERENCES

[i] United Nations, (2014), *World Urbanization Prospects – Highlights.* 2014 Revision. Accessed 10/06/16. http://esa.un.org/unpd/wup/Publications/Files/WUP2014-Highlights.pdf

[ii] United Nations, (2014), *World Urbanization Prospects.* 2014 Revision. Accessed 10/06/16. http://esa.un.org/unpd/wup/Publications/Files/WUP2014-Report.pdf

[iii] The World Bank, Development Research Center of the State Council of the People's Republic of China (2014), *Urban China, Toward Efficient, Inclusive, and Sustainable Urbanization*. Accessed 10/06/16. https://www.worldbank.org/content/dam/Worldbank/document/EAP/China/Urban-China-SRs1-3.pdf

[iv] Urban Hub, *Urbanization on the rise – trends, challenges, the road ahead.* Accessed 10/06/16. http://www.urban-hub.com/ideas/urbanization-on-the-rise-trends-challenges-the-road-ahead/

[v] UN-Habitat, (2007), *Business Partnership for Sustainable Urbanisation.* Accessed 10/06/16. http://mirror.unhabitat.org/downloads/docs/4228_32301_BPSU%20brochure.pdf

[vi] Hargreves, K. and Smith, M. H., (2005), *The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century*. London: The Natural Edge Project, Earthscan.

[vii] Satterthwaite, D., (2008), 'Cities' contribution to global warming: notes on the allocation of greenhouse gas emissions', *Environment & Urbanization*, Volume 20, No. 2. Accessed 10/06/16. http://eau.sagepub.com/content/20/2/539.full.pdf

[viii] Angel, S., Parent, J., Civco, D. L., Blei, A., Potere, D., (2011) ' The dimensions of global urban expansion: Estimates and projections for all countries, 2000–2050', *Progress in Planning*, No. 75. Accessed 10/06/16. http://sollyangel.com/wp-content/uploads/2013/10/2011-The-Dimensions-of-Global-Urban-Expansion.pdf

[ix] UNESCO, (2016), *Collaboration to connect 1.5 billion people by 2020*. Accessed 10/06/16. http://www.unesco.org/new/en/education/resources/online-materials/single-view/news/collaboration_to_connect_15_billion_people_by_2020/#.Vzxqik32a9l

[x] IBM, (2014), *Performance and Capacity Implications for Big Data*, First Edition. Accessed 10/06/16. http://www.redbooks.ibm.com/redpapers/pdfs/redp5070.pdf

[xi] IBM, *What is big data?* Accessed 10/06/16. https://www-01.ibm.com/software/in/data/bigdata/

[xii] UNEP, (2013), *City-Level Decoupling: Urban resource flows and the governance of infrastructure transitions.* A Report of the Working Group on Cities of the International Resource Panel. Swilling M., Robinson B., Marvin S. and Hodson M. http://www.unep.org/resourcepanel/Portals/50244/publications/Cities-Full_Report.pdf

[xiii] Oxford Economics, (2015), *Construction and engineering: Analysis and forecasts for the construction sector*. Accessed 10/06/16. http://www.oxfordeconomics.com/construction

[xiv] Doig., A., Ware, J., (2016), *Act Now or Pay Later: Protecting a billion people in climate-threatened coastal cities*. Accessed 10/06/16. http://reliefweb.int/sites/reliefweb.int/files/resources/act-now-pay-later-climate-report-may-2016.pdf

[xv] Source: Mace estimate

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