THE RISE AND RISE OF URBAN EXPANSION

New cities are sprouting up virtually every day as the world urbanises rapidly. But the projections for the coming decades vary widely. **Michail Fragkias** and **Karen C Seto** analyse the facts and discuss the implications.

Humans have been building cities for thousands of years, but the global shift from rural to urban living has been a defining trend during the past century or so. Even then, contemporary urbanisation – in terms of the combination of demographic, economic and biophysical changes that make cities what they are – is unprecedented in its magnitude and rate. More than half of us live in cities today, and by the end of the century, the number of urban dwellers will swell by another three billion. Although megacities with tens of millions of inhabitants are often in the limelight, most of the urban growth is in fact expected to take place in small- and medium-sized cities of a million or fewer inhabitants (UN 2010). The world will add approximately one new city of a million every five days until 2050. In countries such as India this process is unfolding literally under our eyes: urban centres exist today where villages did only a decade ago.

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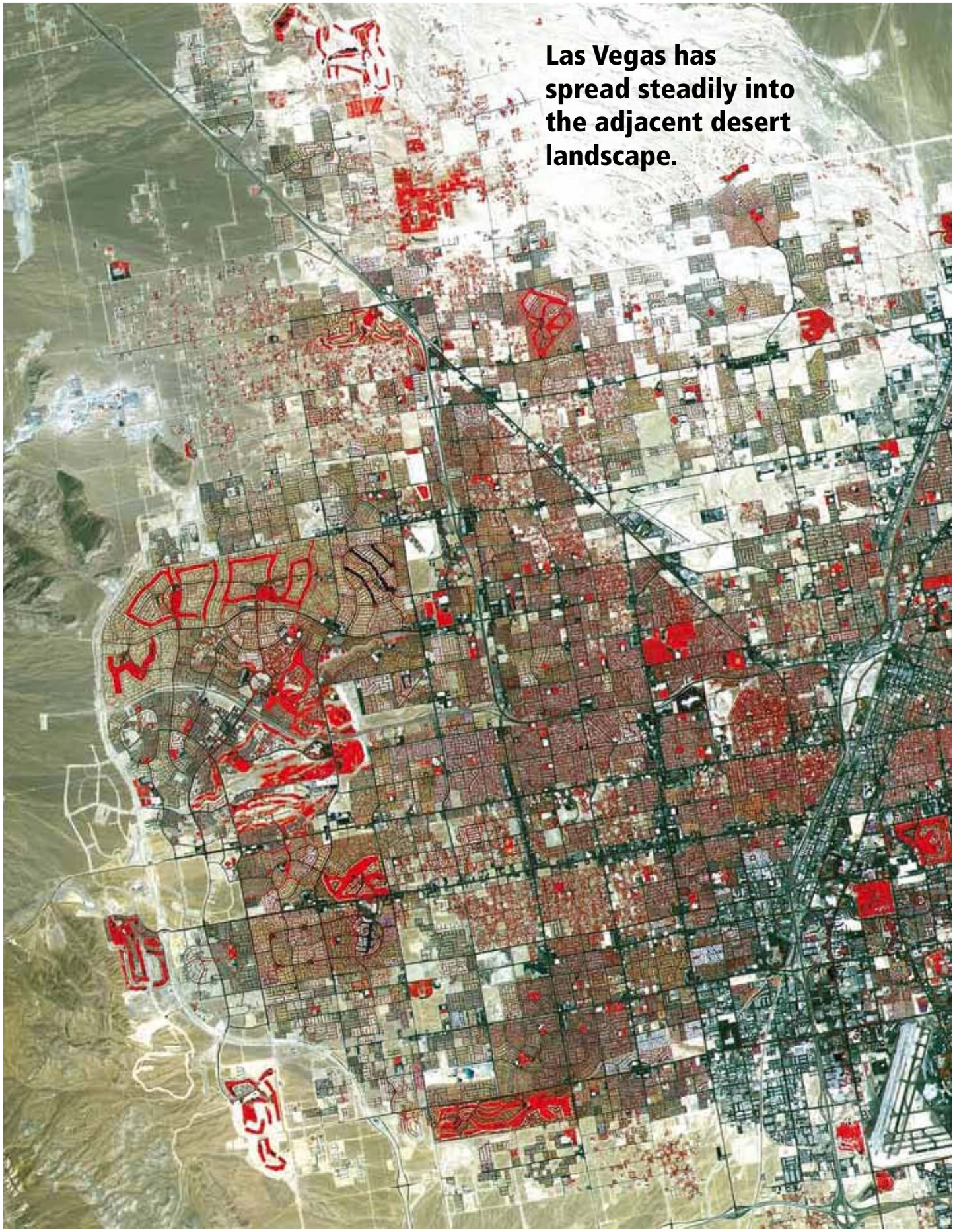
Cities have been the dominant players in the world's socio-economic, cultural, political and environmental spheres. However, today it is urban areas – sometimes cities but at other times more nebulous places that include large swaths extending towards the countryside – that are increasingly important. Such areas produce more than 90 percent of the world's Gross Domestic Product (GDP) (Gutman 2007) and more than 70 percent of the global greenhouse gas emissions. As global centres of production and consumption, they draw resources from around the world. The size and scale of urban population growth and the concomitant urban land-use change pose major challenges to local and regional ecosystems and ultimately the global environment (Grimm *et al.* 2008; Seto *et al.* 2010). At the same time, the dynamism of cities can lead to creative solutions. Two aspects of future urbanisation will determine both how cities might change the world and the extent to which they will be able to adapt to the changes already under way. *Where* urban areas develop – whether in low-lying coastal zones, in agricultural areas, in forested regions or near existing urban centres – will affect their vulnerability to climate change and their ability to draw on the resources needed to provide essential services. *How* urban areas develop – whether expansive or compact, with or without public transportation or with mixed-use or single-use zoning – will determine resource consumption and the urban social fabric, and ultimately global sustainability.

Projections of the urban population for the coming decades are obviously important to understand future urbanisation. The utility of the datasets developed by the United Nations is hampered by the fact that there is no universal definition of what constitutes urban. But these data are available for every country, and until recently, our understanding of the magnitude and rate of global urbanisation was based exclusively on measures of urban population. We know much less about the future rate of growth of urban land area despite the fact that land-use and land-cover change associated with urbanisation is one of the key drivers of global change. There are no global datasets of urban land expansion.

Tracking urban expansion

One way of exploring future urban land expansion is to look at past trends of the same. A recent meta-analysis of 326 peer-reviewed studies based



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on remote sensing (Seto *et al.* 2011; referred to as the Seto *et al.* study henceforth) reports a worldwide increase in urban land area of almost 60,000 km^2 from 1970 to 2000: this is about twice the area of Belgium. The rates were the highest in India, China and Africa, whereas the largest change in total urban extent occurred in North America. Annual growth in GDP per capita drives approximately half of the observed urban land expansion in China but a much smaller fraction in India and Africa; urban land expansion here is driven more by urban population growth.

Rates of urban land expansion by decade reveal three distinct typologies: declining annual rates (Central and South America, Europe, Oceania and Africa), no trend (China, North America and India) and uneven trajectories (Southwest Asia, South East Asia and East Asia). Declining rates of urban land expansion is expected for regions such as South America and Europe, which were already highly urbanised in the 1970s. In contrast, declining rates of urban land change are surprising for Africa, where urban population levels were only 24 percent in 1970.

Much of the observed variation in urban expansion was not dominated by a single variable (population and GDP, for example) in the model. Contemporary urban expansion seems to be governed by a variety of factors difficult to observe comprehensively at the global level, including international capital flows, the informal economy, land-use policy and generalised transport costs.

What about the coming decades? The *Special Report on Emissions Scenarios* (SRES) of the IPCC (http://sres.ciesin.columbia.edu/) provided scenarios at the UN regional level for 2050 based on projections of the global population and GDP.

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Taking these into account, Seto and colleagues developed four urban land expansion scenarios for the year 2030 based on the three different assumptions about the initial urban land cover in 2000/2001. Depending on the initial extents, they forecast increases in global urban land cover of between just over 400,000 and well over 12,000,000 km^2. The primary reason for the large variance in the forecasts is the more than tenfold difference in estimates of contemporary urban land cover. When only MODIS data (which provide reliable estimates at 1 km resolution) are considered, the variation decreases but is nevertheless quite high across the four socio-economic scenarios (Figure 1). The difference in estimates between the highest and lowest scenarios is over a million square kilometres.

Angel *et al.* (2011) also provided projections of urban land cover globally (across all countries and regions) up to the year 2050. They combined population data for thousands of urban agglomerations with populations of over 100,000 people in the year 2000 with the (perceived) highest quality estimates of built-up area for each agglomeration. Assisted by the urban population projections of the United Nations and devising three scenarios of possible changes in density patterns (based on previous global and historical studies), the authors used regression techniques to project land cover to the year 2050. Based on historical observations from cities from different nations and across different world regions, their high, medium and low projection scenarios assumed a 2 percent, 1 percent and 0 percent annual rate of density decline respectively. Their medium projection scenario shows that globally urban land will increase from about 600,000 km^2 in 2000 to over 1,250,000 km^2 in 2030 and to almost 2,000,000 km^2 in 2050.

The situation regarding the urbanisation projections is not too different from that of the projections of global temperature increases – depending on the scenario used the values vary by several degrees. The predictions made by the two studies discussed above deviate significantly and warrant further exploration. The methodologies are distinct, but an important difference is the urban extent assumed for the year 2000. Whereas the Seto *et al.* study uses information from the MODIS Urban Land Cover map at a 1000-metre resolution, the Angel *et al.* study uses data at 500-metre resolution. The sensitivity of the results to this aspect deserves further study. Despite the differences between the studies as well as between individual scenarios in each study, we can expect considerable increases in urban land during the coming decades.

Future urbanisation: challenges and opportunities

About a third of the locations in the Seto *et al.* meta-analysis fall within 10 metres of low-elevation coastal zones. For these areas the average rate of urban land expansion from 1970 to 2000 is almost 6 percent, statistically higher than urban areas elsewhere. In view of the impacts of climate change and projections of regionally varying sea-level rise and storm surges, it seems like humanity has unknowingly been increasing the vulnerability of its urban populations. Also, almost half of the case studies are within 10 kilometres of a terrestrial protected area. Urban land expansion is thus as likely to take place near protected land as elsewhere, and being near a protected area does not necessarily slow the rate

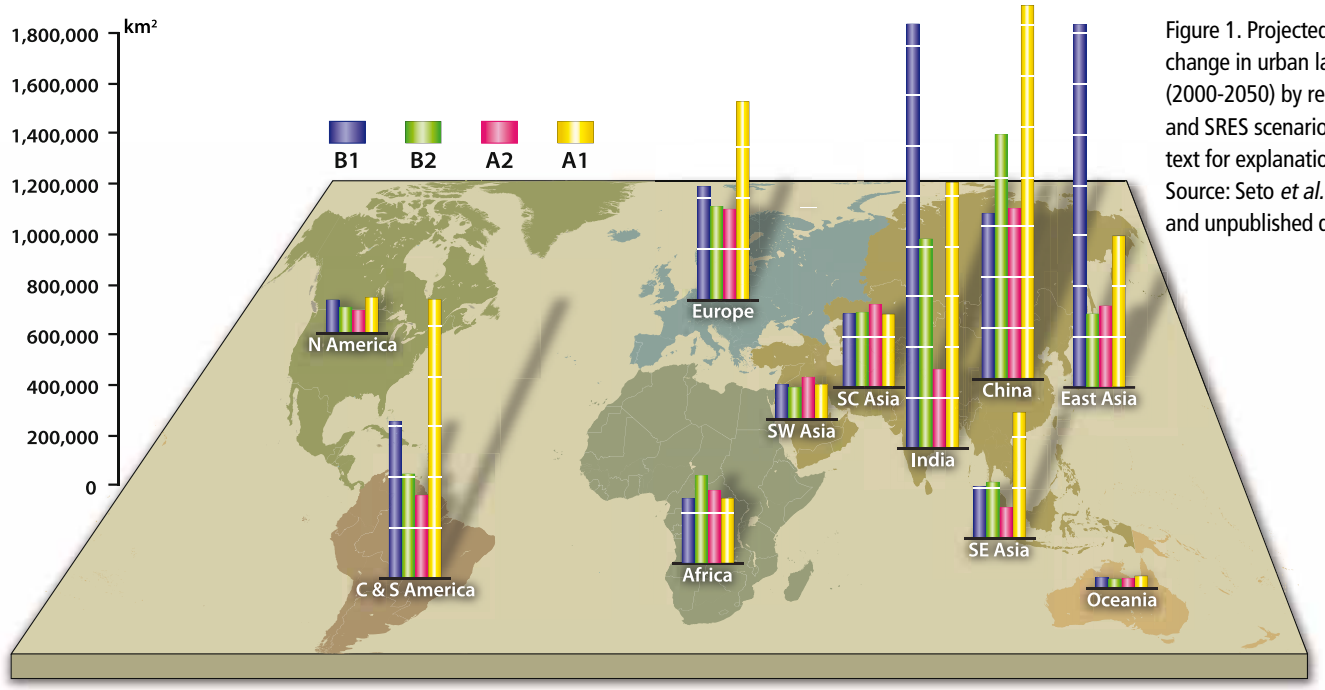

Figure 1. Projected change in urban land area (2000-2050) by region and SRES scenario. See text for explanation. Source: Seto *et al.* (2011) and unpublished data.

of urban-land conversion.

Interestingly, across all regions and for all three decades, urban land expanded at a rate higher than or equal to that of urban population growth. Contrary to what one might expect given the international attention to and calls for sustainable development, urban growth is becoming more expansive than compact. Nowhere do the two studies find evidence of a global increase in urban land-use efficiency or urban population density. Fragmented governance institutions and lack of coordination as well as persistent behavioural norms have prevented the materialisation of international calls for sustainability for two decades. Although action is being undertaken on various issues related to global environmental change, the sheer amount of expected growth can overwhelm the response.

The analysis by Angel and colleagues paints a rather gloomy planning/governance picture. Excluding the case of a significant exogenous shock, the projected expansion of urban land cover is not likely to be contained and difficult to manage. We must accept this fact and be prepared to adapt to it, the authors say. Among the measures they suggest include the realistic projection of urban-land needs, the extension of metropolitan boundaries, acquiring the rights of way for an arterial road grid that can carry infrastructure and public transport, and the selective protection of open space from incursion by formal and informal land development. But the full set of consequences for global environmental change and the wider implications of the urban responses to this change remain unclear.

Contemporary urbanisation has the potential to help the transition to sustainability because of its contributions to innovation, productivity and efficiency. The challenge is to agree on the optimum scale, form and rate of urbanisation, and to build opportunities for sustainability in both the developed and developing countries. An important step would be to employ multidimensional and multiscale approaches to better understand the complexity of urbanisation in the 21st century. ▮

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