

FEEDING THE MEGACITIES OF THE FUTURE

The impact of emerging megacities on the surrounding water and agriculture resources is a growing concern for both experts and local authorities. Classical economic answers, such as the development of global markets, is only part of the solution. One has to think about new relationships with the countryside, as well as developing agriculture activities within cities. May vertical farming be the solution?

In a groundbreaking [report on megacities in 2025](#), the McKinsey Global Institute has shed a new light on the balance of powers that will structure international relations over the next decades. Although contemporary states (between 185 and 193 according to the recognition criteria) should keep their geographic outlines and apparent rights, regarding production, investments and exchanges, the 'productive' world will be in the world's 600 largest cities. In 2025 as in 2007, these 600 cities will generate 60 % of global wealth although the leading members of this urban ranking will have changed altogether.

Human concentrations

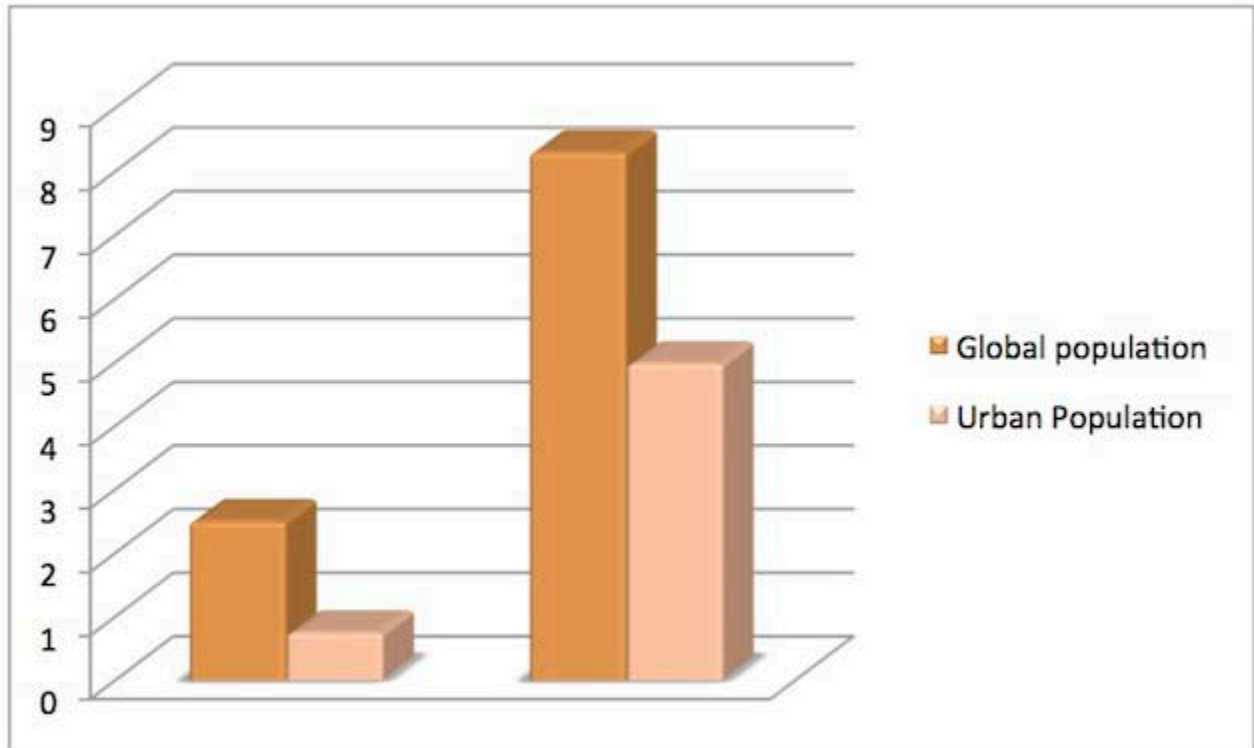
A few figures can help us unveil the extent of this shift. In 2007, half of the global GDP was generated by 380 cities. 20% of this GDP was produced by only 190 North American cities, whereas the 220 largest cities of the developing world produced only 10%. By 2025, one third of these developed-market cities won't even appear in the Top 600. On the other hand, 136 cities of the emerging world will have entered the ranking, including 100 Chinese cities. China is getting ready for a not-so-distant day when it will host one billion urban dwellers. In 2025, China will have 221 cities of over one million inhabitants (in 2013, only 35

European cities have reached this number), including 23 cities of over 5 million inhabitants. The urbanization of the world isn't new, but the center of gravity of this phenomenon is moving south and more decisively, towards the east. Great human masses will concentrate in areas that are poorly prepared to receive them.

Even though the McKinsey study aims at identifying future markets for multinational companies, it raises another question: how can these cities be managed from a sustainable growth perspective, how can we feed this concentration of people inhabitants without harming the ecosystem? Some cities, such as Tokyo (36.7 million inhabitants by 2025) or Shanghai (30.9 million), seem to prepare for the titanic efforts of innovation and rationalization that will be required. Others are clearly overtaken by this unprecedented growth. Examples of these are Lagos (18.8 million), Khartoum (14 million), Mexico City (21.6 million) or Lima (11.7) – the latter will be almost as populated as Paris (12.9). As for Mumbai (22.5) and Bangalore (11.6), two Indian megacities, their dramatic infrastructure shortcomings are already well-known. Two more figures may help us imagine the demographic shift that is at work: by 2030, there will be 276 million more urban dwellers in China and 218 million more in India. The overall increase is equal to the current population of the European Union!

How will megacities feed these populations in a world with limited natural resources? In its last quadrennial report titled [Global Trends 2030](#), result of the analytical work carried out by 16 intelligence agencies and offices, the American National Intelligence Council (NIC) quotes the McKinsey report but focuses on sustainable urbanism i.e. the environmental collateral impacts of the development of megacities. The NIC starts by reminding that, in 1950, only 30% of the 2.5 billion humans lived in cities whereas by 2030, 60% of the 8.3 billion inhabitants will live in urban centers.

World urban and total population, 1950 – 2030



A significant impact

The consequent pressure on natural resources will reach an unprecedented scale. Even if many important urbanism failures of the past are well-known and have been thoroughly analyzed, it would be unrealistic to hope for an improvement of the management of urban development in the future. At this moment, urban densification policies are planned by a handful of countries only. The general tendency is to expand on new territories. The NIC forecasts that by 2030, at least 40 metropolitan areas will overlap two or even three countries, with the economic, politic and ecologic problems that one can easily imagine.

The technologies that can help important urban centers achieve a better control of their energy consumption and carbon emissions are already available. However, most cities – especially in poor countries – will suffer from the traditional impacts of

urbanization at an unprecedented intensity: the disappearance of forests, the impoverishment of the nutritional value and of the microbial composition of soils, the alteration of higher plants and extinction of animal species. All of these impacts have sometimes been measured within up to one hundred kilometers of the city center. According to American intelligence, there are strong chances that these enormous urban centers will start competing between themselves for the same water resources, building grounds and even arable lands. These conflicts will have to be mediated by the intervention of states, if they are strong enough to impose the necessary arbitrations between construction, production and agriculture.

The energy impact of urbanization was estimated and the NIC doesn't hide its concern. By 2030, to take a particularly striking example, the power demand of Chinese cities will double and represent 20% of the global demand. The water needs of the planet should reach 6900 billion cubic meters, 40% more than the current sustainable supply. Indian cities alone will need 94 billion liters of drinking water, although the availability of these amounts is far from secured. Cities of less than ten million inhabitants will form the second wave of urbanization. They will have much poorer infrastructure than megacities and will be more vulnerable. This will be the case of Ahmedabad (India), Huambo (Angola), Fushun (China), Medan (Indonesia) or Viña del Mar (Chile). In some cities, only 10 to 20% of homes are connected to the waste collection network and to the sewers. The transport infrastructure is unable to handle the increase of road traffic: roads are neither large enough nor well-maintained.

The speeding up of urbanization will provoke a triple demand for water, energy and food. These three sectors are completely linked one to the other, as energy extraction and food production are water-hungry activities. The increase of food demand generates serious problems.

Let's remind the context. The world has consumed more food than it has produced during the last seven or eight years: demand will reach its peak increase of 35% by 2030, while the increase of agricultural productivity – around 2% per year between 1970 and 2000 – has decreased to 1,1% and will continue to do so. The need for food production should lead to a doubling of the current levels by 2050. But above all, this increase will not be homogeneous across the different continental regions (a fivefold increase will be necessary in Africa), nor between urban and rural areas, because of the different consumption behaviors of the urban way of life.

Urbanization goes generally together with the growth of the middle class and this social ascent leads, from a nutritional point of view, to an increase of meat consumption. Consequently, this will increase the stress on the demand for grains to feed the cattle. Obviously, you clearly need more water to produce meat than to produce an equal amount of grains or vegetables. Fast urbanization will bring a dramatic pressure on arable land and on water, two necessary resources for food production.

Let us not forget that the availability of agricultural products at reasonable prices is a prerequisite for political stability – all the more so in the case of megacities. It is therefore a true challenge for megacities of the future, especially in emerging countries like Brazil, that don't have rural areas powerful enough to satisfy their needs.

There are basically three different ways of meeting this complex challenge: by extending the geographic framework of the supply of provisions; by re-examining the issue of the rural areas and their development; by searching within the cities the keys to their subsistence.

Global cities, global markets?

One first solution would consist in increasing the global

exchanges of agricultural products. In that way, megacities wouldn't depend as much on their own immediate rural surroundings as on the rest of the planet. Of course, this solution would be the opposite of the "short route" philosophy favored by the partisans of organic agriculture. Nevertheless, it would make sense.

This option would provide a great advantage to megacities in countries with heavy stress on their food supplies, to avoid crises and prices spikes. A dramatic increase in cereal prices triggered, for instance, the beginning of the Egyptian revolution. A greater liberalization of trade would contribute to the creation of global agricultural markets, from which very large cities could draw resources.

A few years ago, Steve Moody (Brigham Young University) has described [some of the mechanisms affecting the price of rice on global markets](#): high customs tariffs from Japan and South Korea has impeded the development of the production in some countries of South-Eastern Asia. These are not able to rely on exports to build up. The trade of rice on global markets is therefore very limited: less than 10% of the global production only. If this production were to decrease by 2%, these 2% would be transferred first to exportations, their impact would be much more significant and could possibly destabilize the market.

Antoine Bouët (IFPRI, Washington DC)) highlights the role of taxes and other restrictions on exportation that are not regulated by the World Trade Organization (WTO), but were nevertheless adopted by many countries (Argentina, India, Ukraine, Russia) when agricultural prices shot up. By taxing exports, domestic prices decrease; but so does the offer on global markets and therefore, global prices increase also.

However, according to Bouët, on the short-term achieving a complete trade liberalization would contribute paradoxically to raising the agricultural prices. The abolition of custom tariffs on importations, of subsidies for production and exportations would lead to the increase of demand and decrease of the offer... therefore to higher global prices. Nevertheless, this trade liberalization would contribute to expand – and therefore stabilize – global markets.

Developing rural areas

The second option is not necessarily exclusive of the first one but emphasizes on the development of local and regional capacities. This option could seem more reasonable if one considers the difficulties encountered currently to achieve the Doha Development Agenda and counter the rise of protectionism. It aims also and above all to avoid a strong inflow of migrants, an issue that we tend to forget about when we speak of urbanization.

As pointed out by Laurent Rosso (ENGREF, Paris), the issue of feeding urban populations cannot be conceived separately from the rise of living standards and the productive capacity of rural populations, which are often poor and malnourished. This issue involves both political (avoiding too strong inequalities) and economic (ensuring the supply of towns) balance. Rural growth, contrary to what the McKinsey report suggests by “isolating” the issue of megacities, is a major issue for the social and political balance of megacities.

Marcel Mazoyer, an agricultural engineer, goes even further: “Among the three billion low-income people, of the two billion that suffer from malnutrition and one billion that suffer from hunger, almost 75% are rural people, of which a significant majority are farmers. 25% of the remaining urban people are either unemployed or have very low incomes. They are generally driven out of the rural areas by poverty and most importantly, by

undernourishment. Poverty is literally generated, renewed and even extended throughout the rural areas of the world. It concentrates in slums that don't offer any perspective of a true solution. The world is in a constant urbanization process, but one could just as well say it is in a spiral of slumization.”

The issue of megacities needs to be reconsidered within this context. Their flows of supplies are linked with flows of migrants and one must constantly keep in mind the fragility of the balances in the surrounding rural worlds, especially in emerging countries.

The countryside inside towns!

Fifty years ago, there were still some farms inside cities like Paris or New York. They all disappeared with the urbanization of the second half of the twentieth century, but they could come back during the twenty-first century. This isn't about raising cattle in Central Park. In the entire world, megacities will be confronted to the same equation: bringing agricultural areas closer to consumers and reducing to the minimum the agricultural surface to leave as much place as possible to housing.

China and more generally Asian countries are at the cutting edge of this issue. [As recently pointed out by the economist Michel Aglietta for ParisTech Review](#), approximately 300 million Chinese will migrate to cities that still don't exist. Before 2030, China must construct for them 200 cities with 1 to 5 million inhabitants. These will be “low-carbon” cities, multipolar cities on the model of Chongqing, to avoid, as much as possible, the anarchic spread and therefore pollution (Chongqing is one the world's most contaminated cities) due to transports. Each multipolar city will contain several sub-cities specialized in a determined productive sector – work places will remain close to residential areas – as well as rural zones to reduce the carbon footprint of the food industry.

Tokyo, the largest city on Earth, also offers an interesting model. One of the world's densest megacities also hosts an important agricultural activity inside its perimeter: 2% of its territory is used for this purpose. Local authorities are even thinking of expanding this surface. One of the provided solutions is "vertical agriculture", an idea that has been promoted since many years by Dickson Despommiers, professor of environmental science and microbiology at the University of Columbia. The goal is to produce great quantities of food products inside a structure that occupies a reduced floor space. According to his theory, a 30-story farm would be capable of feeding 30000 people with a six-fold yield compared with traditional agriculture.

With 5.3 million inhabitants, the city-state of Singapore isn't exactly a megacity but it is an enlightening case as it imports 93% of the vegetables it needs. At the end of 2012, Singapore opened a vertical farm called Sky Greens, an energy and water-efficient closed circuit system based on hydroponic supports. Sky Greens is made of 120 aluminum towers of 9m height each. Each tower offers 38 levels which grow three varieties of salads. Other varieties of vegetables will probably be cultivated in a close future. To ensure maximum sunlight during the whole day, a hydraulic pulley system insures the rotation of the plant containers during the daytime hours. The irrigation and rotation mechanism of the containers are based on the harvesting of rainwater. At full speed, Sky Greens should produce approximately 500 kilos of vegetables per day. The idea has quickly spread.

Sky Greens in Singapore



At the beginning of 2013, the city of Shenzhen, a megacity of its own right with 15 million inhabitants, which is also the world's 5th densest city, has ordered the Belgian architect Vincent Callebaut to conceive six vertical farms. These buildings will host apartments, offices and businesses, but most importantly, they will produce their own food. What was already an emerging trend regarding energy generation – buildings producing their own energy have been built in several cities – could very well become a new reality regarding food supply.

The concept of vertical agriculture offers obvious benefits, but it also faces the barrier of economic profitability. “Vertical farms” i.e. green skyscrapers made of stacked greenhouses, could compete on the housing market of megacities with other economic sectors. City decision-makers could perhaps protect terrains for vertical agriculture by local taxation, but vertical cultures would have to offer a far higher profitability than horizontal agriculture to make the investment worth it. Otherwise, the construction and maintenance costs of such farms could very well equal, or even exceed, the savings on transportation or pollution rights. To make vertical agricultural economically viable, the carbon emission quotas of transports would have to be increased, something the cities of poor countries might certainly not accept easily.

<http://www.paristechreview.com/2013/07/05/feeding-megacities-future/>