

BACKGROUNDER

**Mega-Cities in Asia: An (Un)Sustainable Development?
Industrial Transformation in Asian Mega-cities Impacts on the Environment**

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Sustainability and Mega-cities

Human-imposed threat to global sustainability has two fundamental dimensions: *population growth* and the ever-increasing per capita *demand for good and services*, particularly material needs and energy. Both impose direct and indirect pressures on the human carrying capacity of the Earth.

Today, 75% of the population in industrialized countries lives in urbanized area. Cities and sustainability are inseparably linked. Cities are centers of high living standards, population density, pollutants of air and water and producers of solid wastes. Massive infrastructure developments are underway and consumerism is spreading. The deteriorating environmental situation there has health and welfare implication for urban dwellers. In addition, a degradation of resources due to over-consumption of materials and services will also affect areas and people outside cities and have an impact on future generations.

Mega-cities in particular are characterized by a high population density and high material demands. They are also ‘front-runners’ in terms of urban development, economic growth, industrial transformation, lifestyle changes and policy implementation. From a demand point of view, mega-cities are a root cause of the sustainability problem. However, compact settlements and high population density reduce per capita infrastructure and distribution costs and also open up opportunities for economic scale effects. Thus, mega-cities can greatly facilitate the implementation of measures to reduce stress on sustainability.

Mega-city in Asia on the Rise

Rapid urbanization is a distinctive feature of Asia. For 1990-98, the average urban population growth per year was estimated at 3% for East Asia, 3.2% for South Asia and 2.1% for the world average (WDI, 2001). The potential of urban growth is tremendous in Asia: it is estimated that in developing countries the population in cities will increase from today’s 40% to over 52% by 2020 (Habitat, 2001). This means that by 2030, 2.6 billion people will live in Asia, exceeding twice the current population of the P.R. of China and representing 53% of the world’s urban population (ECO ASIA Report, 2001). Predictions for 2015 show a total of 358 cities worldwide with a population of over a million people, of which 153 are expected to be in Asia (Habitat, 2001). From an estimated 27 mega-cities (exceeding a population of ten millions), 15 such cities will be in Asia. The sustainability implications of these mega-cities will be enormous. *Thus a sustainable management of mega-cities is and will be a major issue for local as well as national policy-makers.*

Our Research

In this context, our research work, undertaken in co-operation with the IHDP Industrial Transformation Project, addresses energy consumption and green house gas (GHG) emissions related policy integration in Asian mega-cities. The aim of our research is to study energy demand and GHG emissions in mega-cities (**Beijing, Seoul, Shanghai and Tokyo** in this phase), and to project future energy demand and GHG emissions under different scenarios, identifying major drivers and locally operational policies and strategies. This includes urban transportation, residential and commercial sectors and urban infrastructure and lifestyles. The aim of this research is not only limited to direct energy consumption and GHG emissions but also to emissions embedded in materials/services consumed in mega-cities but produced elsewhere, and their implications for areas and people outside the cities.

GHG Emissions from Energy Use in Mega-cities: Beijing, Seoul, Shanghai and Tokyo

From 1970-1998, CO₂ emissions from energy use have increased more than two-fold in **Tokyo**, with an average growth rate per year of 2.5 %. During the same time, the annual average growth rate of the local economy (gross regional product) was 6.87%. For 1990-98, annual average growth rates of CO₂ emissions for **Tokyo and Seoul** are estimated at 1.7% and 1.63%, respectively.

In **Tokyo**, most emissions result from commercial activities and transportation (oil and electricity being the main sources of CO₂ emissions). Despite a slowing of economic growth in the 1990s, emissions from sectors such as households, urban transportation and commercial activities, continue to increase. Only CO₂ emissions from the industrial sector decreased gradually, from 34% in 1970 to 10% in 1998.

Households are still the main source of emissions in **Seoul**, while commercial activities cause the least. The economic crisis that gripped South Korea in 1997 had an evident influence on this situation. Oil contributes to nearly 60% of the total CO₂ emissions due to its dominant use in buildings and urban transportation and also because, unlike Tokyo, most of the big buildings in **Seoul** use oil-based central heating systems.

In contrast to Tokyo and Seoul, the industry sector contributes nearly 60% of the total emissions in **Beijing**, followed by households (14%). Urban transportation contributes only about 6%. **Shanghai's** situation is similar to Beijing, with industry contributing over 70% and urban transportation about 9%. Comparing these cities to **Tokyo**, the emission volume of **Beijing and Shanghai** is 1.3 and 1.7 times higher, while **Seoul** emits 0.7 times of the Tokyo value. Our study also shows that economic activity was the major driving force behind the changes in CO₂ emissions in **Seoul** during economic growth as well as economic recession periods.

Energy Demand and GHG emissions

In mega-cities, energy demand results from cooking, lighting, heating/cooling and electric appliances in households and commercial sectors, urban mobility and industries. These activities consume coal, oil, electricity, natural gas, etc., which are sources of GHG and local pollutants. Energy efficiency, frequency and use patterns, fuel choice, fuel quality, and industrial productivity are major factors that govern energy demand and GHG emissions. Usually, mega-cities have a limited scope to modify land-use patterns to achieve maximum efficiency.

Major issues: *The major issue is how to reduce energy demand and GHG emissions while maintaining the urban population's living standards.* Pressure is rising on countries such as Japan, China and Korea to reduce GHG emissions, and this has obvious impacts on cities.

Reducing energy demand and GHG emissions are also related to reducing local air pollution. In **Tokyo**, population growth is more or less stabilized, but per capita energy consumption is increasing. Therefore, major opportunities for policy interventions are in the road transportation and household sectors. Coal use is almost eliminated in **Tokyo**; fuel switching and enhancing industrial manufacturing processes play a minor role in reducing GHG emissions. **Key to these issues is a change in lifestyle and consumer behavior.** In **Seoul**, fuel switching in industries and buildings has contributed significantly to reducing GHG emissions in the last decade. Unlike Tokyo, **Seoul** uses central heating systems in buildings. The potentials for improving energy efficiency and fuel switching are high because in the past switches were mainly from coal to oil and, to some extent, from oil to gas. Road transportation and private cars are another area of concern in **Seoul**.

For **Beijing** and **Shanghai**, industry, buildings and urban transportation are sectors with a great potential for interventions to reduce GHG emissions. In both cities, fuel switching in industries is a viable option. Building insulation, efficiency improvement of electric appliances and fuel switching for central heating systems can also play an important role in reducing energy and GHG emissions. Fuel switching would contribute to significantly reducing local pollutants. In **Shanghai**, car-limiting policies have been successful so far; this city has adopted the Singapore style of auctioning registration permits for new vehicles.

GHG emissions from urban transportation may seem low at the moment for both **Beijing** and **Shanghai**. However, massive investments in the transport systems are planned for the coming years, which bring about the threat of greater energy use, air pollution and GHG emissions. Although, compared to other mega-cities, private cars are relatively little used now, **Shanghai and Beijing** are already suffering from serious air pollution from the transport sector. Further, China's growing economy and WTO membership is likely to increase incomes and reduce tariffs for automobiles (due to competition). Thus, urban planners in **Beijing and Shanghai** are already projecting a 3-4-fold increase of cars and trucks by 2020.

Indirect energy consumption: For a sustainable development, both direct and indirect emissions are of importance. As mega-cities consume huge amounts of materials and goods, this has implications for manufacturing and resource-extraction sites outside cities.

Therefore, cities should be judged by their "*environmental load*", taking also into account indirect emissions. Our analyses suggest that the indirect energy consumption of **Tokyo** (1995) and **Shanghai** (1992) is almost 3 times and 2 times higher than their direct energy consumption, respectively. In **Beijing**, both direct and indirect energy consumption are estimated to be equal. Since energy consumption is the proxy to GHG emissions, the "*environmental load*" that **Tokyo** exerts to other places is significantly higher than its direct emissions.

Countermeasures - Transportation and Building Sectors

Potential countermeasures in the **transportation sector** include a switch to alternative fuels (e.g. compressed natural gas - CNG); promoting electric and hybrid vehicles; increasing average vehicle speed through traffic management; increasing the fuel efficiency of cars and improving fuel quality; improved public mass transportation systems and limiting private cars; and appropriate land-use planning. These measures should contribute to reducing travel demand, trip length and frequency.

In **Beijing**, light duty gasoline trucks and cars are expected to become a key component in future reductions of energy demand and GHG emissions. However, car-limiting policies for new vehicles alone would not be sufficient in **Beijing and Shanghai**; greater efforts are needed to control vehicles in use and to reduce vehicle mileage. Efficient public mass transportation systems are inevitable for these cities. Car-limiting policies are difficult to be implemented in **Tokyo and Seoul**. In terms of fuel efficiency, fuel quality and the end-of-pipe technology at vehicle tailpipe, there is limited scope for further drastic improvement in **Tokyo and Seoul**, but the most promising way is to implement policies that motivate people to change their lifestyle (such as driving behaviour), and to set up a system of parking fees.

The prospects for implementing countermeasures in the **building sector** are also enormous in these cities. This includes improvements in building insulation, appliance efficiency, and efficient central heating systems. Government policies can aim at a building code, laws, and standards for promoting appliance efficiency. Simple measures such as changing from incandescent lamps to fluorescent lamps can save huge amounts of electricity.

The scope for improvements in appliance efficiency may be much less in **Seoul and Tokyo** than in **Beijing and Shanghai**. The use of renewable energy such as solar panel for hot water production, appropriate temperature settings for heating and cooling systems, and avoiding waste of electricity are key to saving energy.

Key messages to policy makers

Mega-cities pose significant sustainability challenges in the future, and the management of mega-cities is a complex and delicate issue.

However, the future is not as dim as it may seem - countermeasures are available.

Policy-maker should think in-terms of "environmental load" on mega-cities that not only considers direct energy demands and emissions, but also the pressures they create on people and places elsewhere.

Improvements in technology, urban management and lifestyle changes are key to sustainable development.

A search for comprehensive measures, understanding all associated issues, and integrated planning are called for.

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