

1.1. Conclusion & Future Projection

This study has constructed inventory of CO₂ and local pollutants from selected cities and their key urban sectors, and embodied emissions as a result of consumption pressure.

The estimation of CO₂ emissions by sector and fuel type suggests that CO₂ emissions in Tokyo has increased more than two times in last three decades with 2.5 % annual average growth rate (1970-1998). During the same time, the annual average growth rate of economy (GRP) was 6.87%. For 1990-98, annual average growth rates of CO₂ emissions for Tokyo and Seoul are estimated to 1.7% and 1.63%, respectively. Beijing and Shanghai's emission growths are significantly higher than Tokyo and Seoul; the estimated annual emissions growths for 1985-1998 are 3.9% and 12.3% respectively while economic growth was about 15% for both cities. In 90's (1990-98) however, the annual growth of emissions are around 2% for Beijing and 5% for Shanghai despite the fact that economic growth rates are over 15%. However in terms of emission volume, Beijing and Shanghai emits 1.3 times and 1.7 times of Tokyo respectively while Seoul emits 0.7 times that of Tokyo. The results have suggested that income effect was primarily responsible for majority of CO₂ emissions in Tokyo and Seoul in high growth period, i.e. 1970-90 for Tokyo and 1990-97 for Seoul. Fuel quality effect and energy intensity effects were largely responsible for reducing CO₂ emissions in Seoul and Tokyo, respectively in that period. Despite economic recession, CO₂ emissions continue to grow in Tokyo in 1990-98, largely due to energy intensity effect. In case of rapidly industrializing Beijing and Shanghai, income effect was found primarily responsible for increasing emissions while energy intensity effect for decreasing emissions.

At present, the vehicle population in Beijing and Shanghai is about 1/10 of that in Tokyo, while their total fuel consumption is only 1/3-1/2 of Tokyo's, which is because of the lower fuel economy and larger VMT in China. In the future, fuel economy should be further improved, and urban transport should be well-developed, especially large-scale public transport. In Beijing and Shanghai, much smaller vehicle fleets emit more amounts of pollutants. Therefore, Beijing and Shanghai should further reduce the VMT of vehicles and strengthen control of in-use vehicles, and the former will be depend on the development perfect urban transport system. The future forecasting of emissions is done in this research. The next phase of research work will be focused on improving the data, scenario and complete other cities while improving the methodology by integrating urban transport plan in the computation

The amount of energy consumption per GRP of tertiary industries in Beijing and Shanghai tends to decrease; however, the results indicate that the amount of commercial energy consumption in those areas will exceed the amount in Tokyo by around 2010. All of the mega-cities have a large percentage of electric energy consumption, and the increasing tendency will continue in the future. Estimations on future expected CO₂ emissions from commercial sectors show remarkable difference from the expected amount of energy consumption in that Beijing and Shanghai are positioned above Tokyo and Seoul, this is true for residential sector as well.

“Direct and indirect energy demand “emphasize the reliance of the mega-cities on outside. Our research show that indirect energy demand in Tokyo and Shanghai is much more significant than direct energy demand, which indicates that these two cities have great reliance on outside in terms of energy demand. Contrarily, direct energy demand in Beijing plays a more important role. indirect CO₂ emission in Tokyo is much larger than direct CO₂ emission (above 2.5 times), which indicate that, in terms of indirect CO₂ emission Tokyo may take much more responsibility in addition to the apparent

direct CO₂ emission. As to say Shanghai and Beijing, we find that the indirect CO₂ emission decreased during the period of 1992-1997. Especially for Shanghai case, the indirect CO₂ emission decreased from 1.9 times of direct CO₂ emission to 0.9 times of it. Which means that the transferring of indirect CO₂ emission in Shanghai and Beijing is not so great as Tokyo. Sectoral contribution shows that secondary industry should take major responsibility for indirect CO₂ emission for all of the cities. As for direct CO₂ emission, Tokyo case show that tertiary industry plays the dominating role and Shanghai and Beijing cases indicate a more important or at least equal role for secondary industry.

In case of waste and energy relation, it is concluded that there is a need to increase recycling/ reuse rate of MSW & to develop more effective policy strategies, especially to reduce food waste generation & its utilization. In case of Beijing & Shanghai, need for new new facilities, policy instruments, & citizen participation is crucial. Seoul needs to increase the operation rate of incineration plants (current rates: 36%) and to benchmark the operation of Tokyo incineration plants. Tokyo perhaps can learn from landfill gas utilization of Seoul.

However, the conclusions drawn from this study are yet tentative need further refinement. This is because APN support duration for two years was basically directed towards making GHG inventory, and fine tuning methodology and facilitating data collection and to some extent making future forecasting. The scenario analyses and implications of the various policy instruments would be next target in 2003/4.

Some observation and future directions are summarized below as:

- The mega-cities being studied under the project seem to differ in both direction and magnitude of development. In terms of emissions, these cities have significant bearing on the national emissions scenarios. These cities also provide an opportunity for implementation of policies to improve the local air quality and health of its citizens. This study also shows the fact that cities provide a viable platforms for application of appropriate policy measures to reduce the national emissions effectively. Energy, transport and waste sectors are the potential target sectors in the mega-cities for this purpose.
- Socio-economic parameters should be taken care of as these have strong bearings in the implementation of any policy decisions in future.
- The data and modelling are important but how much analyses is necessary and sufficient for policies are open question. So we must adopt strategic approach on finding solution
- To make complex analyses accessible to others, our reports and books (possibly) deal with care for questions such as how to present results, how to interpret them and how to make them understandable to policy makers.
- We need to address micro-economic aspects such as price implications.
- The unique features of each cities should be taken into account in policy measures or countermeasures
- Though mega-cities are important, smaller cities are need attention.
- Governance, institutional and legal frameworks questions are need to be addresses and included in the analyses.
- We continue this research in future with support of all collaborators and supporters.

One of the key issues faced by this research was data availability and slow pace of methodological developments for integrated analyses. The case study cities in this

research are relatively in a better position for data and information availability compared to other cities in South East Asia and South Asia. The delicate balance of methodology and data availability is a key issue that deserves a careful further look in the Asian region. Since Asia would be the home to majority of mega-cities in the world and it has tremendous potentials for medium and small size cities, role of cities in global climate change debate would be important in the future. In that sense, the capacity building of doing research in this areas is needed to be further enhanced with due consideration to methodological enhancement, data availability and capacity building of researchers to carry our urban energy and emissions research. The project would wish to open a dialogue in scientific circle reflecting regional consideration to these issues, and go one step ahead by expanding such analyses covering all major mega- and medium scale cities.