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Role of science and technology in environmentally-sound urbanization in China

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Abstract—In the process of accelerating industrialization, urbanization is inevitable and important to China's modernization drive. While people are cherishing the advantages of living in cities, the increasing negative impact of urbanization has to be put on the top of priority list. As urbanization proceeds, the existing pollution problem aggravates with not only increasing quantity of pollutants, but diversity as well. Science and technology have been contributing to urbanization process in both positive and negative ways. Nonetheless, the role of science and technology in promoting sustainable urbanization is increasingly important. China has been conducting environmental research and development since the early 1970's, and now is capable of supplying most technologies needed for urban environmental protection. To keep pace with the rapid urbanization process in China, environmental research and technology development should be strengthened. This is mostly dependent on domestic resources with introduction of advanced yet cost-effective technologies from the rest of the world. With a survey of current urban environmental R & D in China and on-going activities of the Chinese Academy of Sciences (CAS), recommendations on future UCL (University College London)-CAS collaboration in the domain of urban environment are made.

Keywords: science, technology, urbanization, environment.

1 Briefing urbanization process in China

1.1 The importance of urbanization to China's modernization drive

The first and foremost benefit of urbanization in China should be attributed to the economic growth, which is the primary concern of not only the government, but the ordinary people as well. In the urbanization process, the secondary and consequent tertiary industry can be developed rapidly. In particular, a bigger share of tertiary industry in total economic pattern could result in the shift of economic structure. By promoting the secondary or even tertiary industry, the total social productivity will be increased dramatically, which in return, provides solid base for urbanization. Practices in China indicate the important role of urbanization in increasing the national economic strength.

The social benefits are another important aspects of urbanization, which should also be addressed to meet the concern of both government and ordinary people. Life quality can firstly be improved with urban infrastructure completion. The urbanization process in rural areas could benefit the urban-rural coordination. The surplus of rural labor force can be employed to tertiary and secondary industries, which could have otherwise been impossible. With better education facilities in the urban areas, education level could also be increased, and there will be more opportunities to apply science and technology in production.

1.2 Status of China's urbanization

Before the 1980's, China's urbanization process was marked with late take off, low level and high instability. Urbanization in China is 100 years later than most developed countries, and even 20 years later than less developed countries. Urban population in China in 1950 was 17% lower than the world average and 40% lower than developed countries. The fluctuation caused by politics, policy change and resource constraints had been very high.

Since the 1980's, China has been experiencing a rapid urbanization process characterized by rapid growth of urban population. In 1985, the urban population in China was 251 million resided

in an area of 9000 km^2. Yet in 1997, urban population in China increased to 370 million with urban area of 21000 km^2. However, this is still regarded as behind income level and industrial structure change. And the infrastructure has yet to be greatly improved.

Because of increasing migrating population from rural to urban areas, and rapid development of small cities and towns, it is now very hard for urban environment management. For instance, there were only 190 million urban residents out of the 370 million urban population in 1997, which means that rural migrating population were 180 million.

Although we had an urbanization rate of 32% in 1997, there were great regional disparities. In this case, China can be divided into coastal, large river delta, north and northeast, and northwest inland areas. Most of the large cities are located in coastal and large river delta areas, as well as the capital area and northeast. Due to the radiation effect of large cities, small cities and towns have also been developed rapidly. Urbanization rate in these areas is far more rapid than the inland areas. Of course, the development model in those areas is very much different. There is a big regional disparity in China in terms of urbanization. Geographically, there is a ladder trend from the east to the west.

1.3 Trend of China's urbanization

China's urbanization process is now characterized by the trend of globalization, the formation of pyramid continuum, urban ruralization and rural urbanization. Take the export and import situation for example, from 1978 to 1997, China's total export increased from US $ 5 billion to 190 billion, while import from US $ 6 billion to 150 billion. In the coastal and delta areas, the big-medium-small city web has been formed. Municipal area expanded from 450000 km^2 in 1985 to 845000 km^2 in 1997, which means urban areas have been expanding with large surrounding suburban areas. While urban areas of small cities and towns scattering in the rural areas increased from 9000 km^2 in 1985 to 21000 km^2 in 1997.

2 Urban environmental problems and resolutions

2.1 Increasing environmental impact of urbanization

As urbanization proceeds, both pollutant quantity and diversity increase, while green space expands resulting in the loss of prime farmland. The following table tells the story from 1990 to 1997.

Table 1 Pollutant increase in urban areas

Year	Polluted water	Treat capacity	Solid waste	Treated	Green space
1990	12 bi. m^3	32 bi. m^3	90 mi. tons	21 mi. tons	33000 hm^2
1997	35 bi. m^3	13 mi. m^3	140 mi. tons	76 mi tons	108000 hm^2

The most serious problem of air pollution is acid deposition resulted from coal combustion. In 1996, of the 84 cities surveyed, 43 have lower pH than 5.6, amongst, Changsha has the lowest pH of 3.5 with frequency of 90%. Automobile exhaust is producing NO_x emission in an unprecedented way, which is now the biggest threat for most cities, north and south. In the 88 cities monitored, NO_x emission ranged from 5 to 152 $\mu g/m^3$, with average 53 $\mu g/m^3$ in the north and 41 $\mu g/m^3$ in the south. The most seriously polluted cities with NO_x are Guangzhou and Beijing.

Water pollution is the increasing major concern in urban environmental issues. Amongst the investigated rivers passing through cities, 78% of them are non-drinkable, and ground water contaminated by 50%. Take Taihu Lake for example, water quality there in 1960's was grade I,

while in 1990's grade IV. Apart from the increase of pollutant quantity, the pollutant diversity is also increasing, such as new microbe tide in the Taihu Lake, 2/5 polluted in 1970's, 3/5 in 1980's and 4/5 in 1990's.

Solid waste is another increasing problem, which forms a pollutant circle around cities, large or small. Solid waste disposal not only invades prime farmland, but causes severe water and air pollution as well.

Loss of green space in downtown area and prime farmland in suburbs are also increasing impact of urbanization. Because of the contradiction between great demand of car park supply and limited urban space, green spaces for urban recreation activities are often used as car park. While the building up of new urban areas causes loss of prime farmland.

2.3 Urban environmental protection

China has been developing pollution control technologies since the 1980's. The technologies mainly address issues of water, air and solid waste pollution. Improvement of energy production and consumption structure is an important way to control air pollution and cleaner production technology is vital for water pollution control from the source instead of end-of-pipe

Planting trees and grasses in cities is another active approach to improve urban environment. In 1985, there was only 1.6 m^2 of green space per capita, yet by 1997, there was 2.9 m^2 green space per capita.

3 The role of science and technology in improving urban environment

3.1 Assessment of China's environmental science and technology

China started her meaningful research projects of environmental sciences in the early 1970's, firstly with a survey of pollution sources and then the study of the technology for controlling industrial pollution. Through 20 years of efforts, a number of valuable results have been achieved. The research on the protection of environment has developed from only technology for controlling industrial wastes to integrated measures, from the control of pollution sources to regional comprehensive control, from passive purification of pollutants to cleaner technology and making pollutants resources.

By the end of 1995, 390 institutions engaged in environmental scientific research and technology development, with a multidisciplinary team of more than 20000 research and management personnel. Those institutions belong to concerned ministries and commissions of the State Council, the Chinese Academy of Sciences, universities, provinces, municipalities and autonomous regions. The investment in environmental scientific research accounts for 0.75% of total investment in scientific research in China.

With the complementation of the measures mentioned above, a series of results and technologies have been achieved, providing a solid base for the development of environmental protection industry.

In the past five years from 1991 to 1995, the selection, assessment and extension of best environmental practice have been developed. There were 1316 practical techniques recommended, of which 438 were selected and 385 have been used in 140000 units. These techniques helped not only to reduce pollutant discharge, but also to benefit the users.

Environmental protection industry (EPI) is a burgeoning industry composing technology development, product manufacturing and marketing, resource utilization, information service and engineering contract for environmental pollution control, eco-environment improvement and rational utilization of natural resources. By May 1996, there have been 8651 enterprises with 1.88

million personnel engaging in EPI. The fixed assets for those enterprises were 45.011 billion RMB Yuan, annual output value 31.148 billion and profits 4.091 billion.

3.2 Addressing urban environmental problems

Since the 1980's, the Chinese government has made family planning and environment protection two basic national policies. And then China declared two national strategies, sustainable development and thriving the country with science and education. The former senior Chinese leader Deng Xiaoping even claimed science and technology as "No. 1 productivity".

Science has long been incorporating into China's modernization process, leading to remarkable progress toward sustainable development. Science can only be meaningful when rooted into processes of policy-making, planning and implementation. For years, science has been playing key role in enhancing China's sustainability, while the need for science and technology provides precious opportunity for their advancement.

To accomplish Agenda 21 in China, the State Planning Commission (SPC) and State Science and Technology Commission (SSTC) took the lead in organizing concerned ministries and institutions to formulate China's Agenda 21 in 1993. In its 9 Priority Programs formulated in 1994, 4 directly address urban problems:

Priority 3: cleaner production and environmental protection industry;

Priority 4: clean energy and transportation;

Priority 6: environmental pollution control;

Priority 8: population, health and human settlements.

Under the guidance of the national Agenda 21, each ministry and/or institution under the State Council has put forward their own agenda and priorities. Local authorities have also been active in drafting plans for implementing Agenda 21 at local level. Amongst all these local or provisional agendas, urban issues are put on the top of their priority list.

4 Contribution from the Chinese Academy of Sciences

4.1 On-going activities

The Chinese Academy of Sciences fathered the research work on urban environment protection. About 40 institutes among the total of 120 are involved in the research and technology development on urban environment. National laboratories of RS (remote sensing) and GIS application in CAS have been very helpful for urban planning and development. While laboratories of water and atmospheric chemistry are mainly on the research to protect the urban environment from pollution.

The Chinese Academy of Sciences is also the forerunner of pilot studies on urban environmental R&D. Demonstration work has been conducted as a result.

Industry is mainly developed in urban or suburban areas. Industrial pollution control is therefore the major way to clean up the urban environment. One striking example for industrial pollution control based on cleaner technology is cleaner chromate production demonstration, which resulted in a totally revolutionary pollution free production line. In addition, investment can be reduced by 30%, and production cost by 15%.

In terms of end-of-pipe solution, another technology of microbiological treatment of electroplating wastewater and its sludge is being implemented in lots of cities and towns.

As coal accounts for 75% of China's energy supply, the Chinese Academy of Sciences has developed cleaner coal technology to reduce air pollution in urban areas. The typical example is the 150 MWE pressurized fluidized bed combustion (PFBC) combined cycle demonstration power

plant.

4.2 Future projections

The future plan in the domain of urban environmental science and technology will be focused on: Cleaner technology; bio-technology for both source and end-of-pipe solution; RS/GIS/Information technology synthesis for urban administration supporting system; new and cost-effective waste recycle technology; macro policy consultation on sustainable urban environmental management.

5 Perspectives in Sino-British collaboration on urban environment

5.1 Comparison

To formulate a pragmatic Sino-British collaboration program, a comparison has to be made in search for similarities or differences between Chinese and British urban development.

Table 2 Sino-British comparison

Items	China	UK
Development stage	Agricultural-industrial era	Post industrial era
Process	Urbanization	Ruralization
Urban situation	Macro-diversified	Micro-diversified
Economy	Take-off economy	Knowledge-based economy
R & D	Strong R/weak D	Strong R/Strong D
Investment	Limited capital resources	Rich capital resources
Mechanism	Yet-to-complete	Perfect

5.2 Suggested topics and mechanism of CAS-UCL collaboration

The following topics are suggested for consideration of CAS-UCL collaboration: Environmental policy and economics; urban environmental management (including environment impact assessment); 3S and computer-aided urban planning; cleaner technologies; biological technologies; urban recreation ecology.

The mechanism for collaboration proposed will be: Strong-strong union; complementary/strong-weak partnership; pragmatic and step by step priority identification.

References

Chen X, Hu A, 1996. Opportunities and challenges. Beijing: Science Press. 6

Liu J. The environmental costs of development in the transition period. 11 EED working paper. Oslo, Norway. 1994/3

NEPA(China), 1997. Environmental bulletin of China. Beijing: Environmental Press

State Planning Commission and State Science & Technology Commission, 1994. Priority programme for China's Agenda 21

State Statistical Bureau, 1997. China statistical yearbook. Beijing: China Statistics Press