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Urban environmental and economic performance linked to sustainability: Evidence from big and medium size Chinese cities[1]

Meine Pieter van Dijk[2] and Zhang Mingshun[3]

Abstract

This paper is based on research in Chinese cities. It addresses the issues related to urban environmental performance and sustainability in emerging Chinese cities. The result shows that: (1) To basically control the degradation of urban environment the minimum per capita GDP should be about 1000 USD in China. This amount is only one third of that in the developed world; (2) The average share in GDP necessary for environmental investments is 2.9%. Such an amount would help to avoid further urban environmental degradation in Chinese big cities. 1.7% of GDP would be necessary for medium-sized cities. These environmental investments will have a positive impact on local economic growth and social progress; (3) Cities are in different stages from non-sustainability to sustainability, and the major characteristics of cities in these different stages will be presented in this paper; (4) It is obvious that significant differences in urban environmental management exist in cities that were identified and which are at different stages of urban sustainability; (5) Directions for improving urban environmental management and sustainability in China will be recommended.

1. Introduction

Zhang (2002) suggests letting the concept of urban sustainable development include economic, social and environmental requirements (also Munasinghe, 1993). Embracing sustainable development is the recognition that too many things have gone wrong, and past development efforts have achieved only a part of what should truly comprise human development. Achieving urban sustainability in the short run may be an illusion. However, the question is can we have economic growth, social progress and a sound environment all in one package (Ho and Vermeer, 2006)? The concept of urban sustainability almost seems to neglect that there are tradeoffs among these three goals. However achieving these three goals: economic, ecological and social justice is a real challenge for the world. The concept of sustainable development emerged because of environmental issues, and environmental decline is believed to be the first sign of non-sustainability. Given the scale and nature of environmental damages, sufficient evidence exists to support the view forwarded by advocates of sustainable urban development that priority must be given to the physical environment. The task is not simple, and exploring the possibilities of coordinated socioeconomic and environmental development in the context of urban China will have a great policy relevance.

Our analysis of urban sustainability in China will focus on five issues, based on the context of urban China. The issues are:

(1) To what extent of economic development measured by GDP, are the environmental and economic values not in conflict?
(2) What is the necessary environmental investment for controlling urban environmental

degradation and improving urban environment?

(3) Can we distinguish different stages in Chinese urban sustainable development? and

(4) What are the emerging features of urban environmental management in different stages of urban sustainability mention-above?

(5) What are the directions for improving urban environmental sustainability?

2. Economic development and environmental degradation

Environmental information has been combined with economic statistics (for example GDP or income) to examine the relationship between environmental quality and economic development. These are known as environmental "Kuznets curves". A Kuznets curve is named after Simon Kuznets who hypothesized a relationship between economic growth and income distribution, in which distribution worsened initially with growth, but improved later as growth continued. Environmental economists have borrowed the term to apply to the relationship between economic growth and environmental quality. The argument being that as economic growth occurs so environmental quality tends to get worse at first, but then gets better. Various statistical tests of the environmental Kuznets curve have been carried out (Grossman and Krueger, 1994; Grossman, 1995; Seldon and Song, 1994). A review by Pearson (1995) suggests that inverted U shapes exist for the traditional air pollutants such as Total Suspended Particulate (TSP), NO_x, and SO_2.

This refers to our first issue: To what extent the environmental and economic values are not in conflict, or what are the relationships between economic development and peak of environmental damages. It is recognized that environmental degradation is the result of economic growth, especially mismanagement. The theory of treatment after pollution argues that environmental damages is inevitable at the initial stage of economic growth, and only when enough economic development is achieved the environmental degradation can be controlled and then improved. In the 1980s, Chinese scholars criticized this argument for two reasons. One is that experiences from developed countries show that more ecological compensations are needed during the serious pollution stage than in the initial stage, and thus, the best thing to do is to prevent pollution. The other is that the theory of treatment after pollution could stimulate activities damaging the environment. As a result, in 1982, China has accepted three basic environmental policies, such as prevention first, polluter pays principle and strengthening environmental management. A key environmental protection strategy, such as economic growth, urban-rural construction and environmental protection must be planned, implemented, and developed through coordination.

We do believe that the three environmental policies as well as the key environmental strategy have played the central role in Chinese environmental protection. However, examples of treatment after pollution have also been observed since the 1980s. It is certainly recognized that environmental degradation is related to economic growth. Figure 1 presented the two main pollutants emission and GDP per capita in China since 1986. It shows that both waste water discharges and SO_2 emissions increased until 1998, while GDP per capita had increased by

8.7% in average. Nationwide, the year of 1998 was the top year for wastewater discharge and SO_2 emission, and GDP per capita was 6392 CNY (eq. 800 USD) at that time. State Environmental State Reports showed that, compared to the data in 1997, 12 main pollutants' emissions had decreased, and environmental quality had been improved slightly in some of the cities, especially in the metropolis in 1998. Empirical evidence in the developed world (Niu, 1999, 1) suggests that environmental pollution is at its most serious stage when the nation's GDP per capita is between 500 and 3000 USD. This is the initial stage of the nation's industrialization and urbanization and this is also the most difficult time for achieving the three objectives of economic growth, social progress and environmental quality. If the GDP per capita is less than 500 USD, the major problem could be ecological destruction resulting from unreasonable natural resources extraction, given the wide-spread poverty and proliferation of small scale industries (Van Dijk, 2003). If the GDP per capita is more than 3000 USD, reasonable resources could be available for controlling environmental pollution, and even for improving environment.

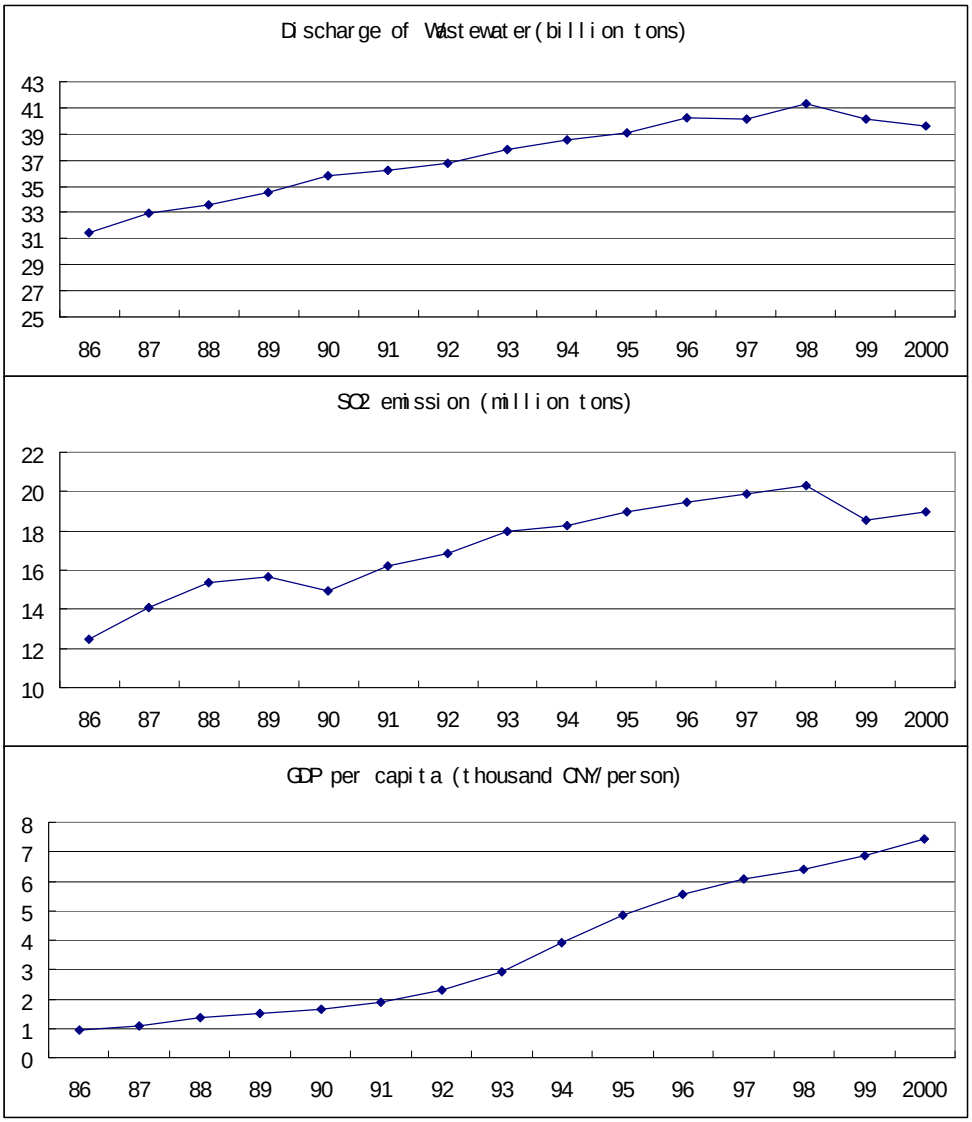

Figure 1 Waste water and SO_2 Emissions and GDP Per Capita in China since 1986

Source: China's Environmental Statistical Report, 1987-2001 and China's Statistical Yearbook, 1999.

Many Chinese scholars argue (Mao, 2000; Ye, 2000; Wang, 2000) that environmental quality in China was at its transition period between 1998 and 2002, when per capita GDP was between 800 and 1200 USD. It sounds like the minimum per capita GDP should be about 1000 USD in China to basically control the degradation of environment. This amount is only one third of that in the developed world. The reason is complex, and one possible explanation for this phenomenon could be provided by the theory of latecomer's superiority. The theory argues that it is easier for latecomers to do the same thing than the forerunners, since more resources, such as experiences, knowledge and skills and information are available for the latecomers. Various Chinese scholars have addressed this issue (Liu, 1998; Zhang, 1999a; Kong, 2000). In fact, among the eight urban environmental management systems in urban China, three (environmental impact assessments, discharge fees and emission permits) are imported from developed world. In addition, China has also drawn lots of ideas and experiences from developed world with regard to environmental regulations and laws. By learning the successful experiences and management knowledge from overseas, China's urban environmental management, started in 1980s, is going fast, and has contributed significantly to urban environmental protection.

With respect to the minimum level of urban economic development for controlling environmental degradation, important differences do exist from city to city. In China, a big city (metropolis is inclusive) is defined as a city which population is one million or more. A medium-sized city is defined as between one million and 200 thousand inhabitants. For the purpose of this research, we use the concept of environmental index developed by this research program. The environmental index was defined as the aggregation of six environmental indicators by weighting, such as daily concentration of SO_2, daily concentration of PM_{10}, percentage of water meeting the drinking quality standards, average concentration of COD, per capita area of arable land and per capita water resources.

Table 1 presented the turning point of delay of urban environmental quality in 22 big cities, and Table 2 presented the turning point of further degradation of urban environmental quality in 29 medium-sized cities.

Table 1 Turning point of further degradation of urban environmental quality in Chinese big cities

City	Year of turning point of environmental index	Environmental index for the year	GDP per capita for the year (CNY/person)
Beijing	1999	0.41	16,443
Shanghai	1997	0.52	25,727
Tianjing	1998	0.47	13,276
Shengyan	1998	0.35	15,007
Dalian	1996	0.54	13,370
Haerbing	1999	0.37	10,783
Nanjing	1999	0.39	17,308
Shuzhou	1999	0.47	23,769
Hanzhou	1999	0.51	15,982
Ningbo	1999	0.31	18,387
Xiamen	1997	0.41	29,370
Qindao	1997	0.49	13,830
Guilin	1997	0.57	13,687
Guangzhou	1998	0.39	25,689
Shenzhen	1996	0.48	56,470
Average per capita GDP of the cities for the year of turning point: 20,606 CNY or 2,500 USD Average environmental index of the cities for the year of turning point: 0.45			
Chengdu	2000	0.35	12,070
Chongqin	2000	0.28	5,137
Taiyuan	2000	0.25	8,432
Changchun	2000	0.38	9,873
Jinan	2000	0.40	17,754
Wuhan	2000	0.37	11,507
Xian	2000	0.32	11,659
Average per capita GDP in 2000 of cities still with environmental decay: 10,919 or 1,300 USD Average environmental index of cities still with environmental decay: 0.34			

Sources: China's Statistical Yearbook, 1997 – 2000; China's Environmental Statistical Yearbook, 1997 – 2000.

Table 2 Turning point further degradation of urban environmental quality in Chinese medium-size cities

City	Year of turning point of environmental index	Environmental index for the year	GDP per capita for the year (CNY/person)
Yiyan	2000	0.24	6,453
Taian	2000	0.35	7,701
Dezhou	2000	0.37	7,787
Liaocheng	2000	0.27	5,127
Zhuzhou	2000	0.34	9,864
Wuhu	2000	0.37	9977
Yanquan	2000	0.39	6,893
Wu	2000	0.18	7,796
Chifeng	2000	0.17	5,632
Benxi	2000	0.19	8,754
Jinzhou	2000	0.27	7,435
Huibei	2000	0.28	6,669
Huinan	2000	0.29	8,144
Ta	2000	0.17	24,658
Chuzhou	2000	0.32	7,645
Huanshan	2000	0.36	6,004
Jingzhou	2000	0.38	8,765
Chaozhou	2000	0.39	8,130

Xiantan	2000	0.30	7,892
Nantong	2000	0.32	8,652
Average per capita GP in 2000 of cities still with environmental decay: 8,499 in 2000 (or 1,050 USD) Average environmental index of cities still with environmental decay: 0.30			
Yanzhou	1999	0.56	12,347
Jinghua	1999	0.51	21,219
Zhangjiagan	1999	0.31	1,4764
Sanming	1998	0.49	12,988
Weihai	1997	0.64	19,586
Zhongshan	2000	0.32	11,354
Dongyin	1999	0.39	18,639
Shangdou	1998	0.42	21,465
Sanya	1997	0.68	9,356
Average per capita GDP of cities for the year of turning point: 15,746 (or 1,900 USD) Average environmental index of cities for the year of turning point: 0.48			

Sources: Shandong, Hunan, Anhui, Inner Mongolia, Liaonin, Zhejiang, Hebei, Hubei, Guangdong, Jiangshu, Fujian and Hainan provincial statistical yearbooks, 1997 - 2000; Environmental state reports, 1997 – 2000.

Table 1 and Table 2 show that:

- Environmental quality is not very satisfactory in almost all cities, as the average environmental index is 0.40. The latter figure is defined as the lowest line of very weak urban environmentally sustainability;
- Among the 22 big cities, 15 (68%) are now at that stage where environmental decay is no longer linked with economic growth, and some of them have achieved great progress in improving urban environment. However, among the statistics for the 29 medium-sized cities, only 9 (31%) are already at that stage.
- The average per capita GDP of the big cities for the year of turning point of urban environmental decay is 2,500 USD, while it is 1,900 USD in medium-sized cities. Both are much higher than the national average of 1000 USD per capita, which is estimated as the necessary economic scale for controlling national environmental decay. The average environmental index in the big cities in the year of the turning point of further degradation of urban environment is 0.45, and 0.48 for the medium-sized cities. Both are in the range of very weak sustainability (0.40-0.49);
- The average per capita GDP in 2000 of the big cities that are still at the stage of environmental decay is 1,300 USD, while for medium-sized cities it is 1,050 USD. The average environmental index in 2000 for the big cities that are still at the environmental decay stage is 0.34, and 0.30 in the medium-sized cities. Both are in the range of non-sustainability (0.30-0.39, see Table 4.2). Suppose that the urban average per capita GDP growth rate is 10%, most of the big cities will still have 5-6 years to go to reach the per capita GDP of 2,500 USD. Likewise most of the medium-sized cities will still have 5 years to go to reach the per capita GDP of 1,900 USD. Therefore, it is very likely that most of the Chinese cities could reach the necessary economic level, and be able to successfully control their urban environmental degradation in the

coming five years.

The facts that we have discussed in the selected cities as well as those presented by the other Chinese scholars show that economy in all Chinese cities is growing fast. However, the total urban sustainability is weak. The key problem is the degradation of the urban environment. Urban environmental problems may worsen or improve with economic growth; some worsen, then improve. From Table 1 and Table 2, we argue that economic development can play the central role in improving urban sustainability, and that per capita GDP of 2,500 USD could be the least economic level for controlling and improving urban environment in big cities, while per capita GDP of 1,900 USD could be necessary for medium-sized cities to do so.

3. Environmental investment and environmental improvement

What is the necessary environmental investment for controlling urban environmental degradation and improving the urban environment? This is the most frequently mentioned issue in urban China. At the end of the 1980s, many Chinese scholars (Qu, 1983, p.212) estimated that 1% of environmental investment sharing in GDP was necessary for controlling the urban environmental degradation, and 1.5% for improving urban environmental quality. In 1993, the Program of Research on Strategic Objectives of China's Environmental Protection (Hang, G. 1993, p.43) estimated that 1.73% of environmental investment sharing in GDP was necessary for controlling urban environmental decay, and 2.0% for improving urban environmental quality.

We have also explored the necessary environmental investment for controlling urban environment. Table 3 shows the result in the 22 big cities and Table 4 shows the result in the 29 medium-sized cities.

Table 3 Environmental investment in big cities

City	Year of turning point of environmental index	Environmental index for that year	Environmental investment as share of GDP (%)
Beijing	1999	0.41	3.53
Shanghai	1997	0.52	3.18
Tianjing	1998	0.47	2.85
Shengyan	1998	0.35	2.53
Dalian	1996	0.54	3.37
Haerbing	1999	0.37	2.19
Nanjing	1999	0.39	2.72
Shuzhou	1999	0.47	3.54
Hanzhou	1999	0.51	2.27
Ningbo	1999	0.31	2.64
Xiamen	1997	0.41	2.76
Qindao	1997	0.49	3.18
Guilin	1997	0.57	1.94
Guangzhou	1998	0.39	3.12
Shenzhen	1996	0.48	3.71
Average		0.45	2.90

Chengdu	2000	0.35	1.98
Chongqin	2000	0.28	1.94
Taiyuan	2000	0.25	1.55
Changchun	2000	0.38	1.61
Jinan	2000	0.40	2.67
Wuhan	2000	0.37	2.54
Xian	2000	0.32	1.29
Average		0.34	1.94

Sources: China's Environmental Statistical Yearbook, 1997 – 2000.

Table 4 Environmental investment in medium-size cities

City	Year of turning point of environmental index	Environmental index for the year	Environmental investment share in GDP (%)
Yiyan	2000	0.24	0.73
Taian	2000	0.35	0.82
Dezhou	2000	0.37	1.29
Liaocheng	2000	0.27	0.59
Zhuzhou	2000	0.34	0.92
Wuhu	2000	0.37	1.21
Yanquan	2000	0.39	0.87
Wu	2000	0.18	1.27
Chifeng	2000	0.17	0.59
Benxi	2000	0.19	1.87
Jinzhou	2000	0.27	1.05
Huibei	2000	0.28	0.94
Huinan	2000	0.29	1.12
Ta	2000	0.17	0.91
Chuzhou	2000	0.32	0.94
Huanshan	2000	0.36	1.15
Jingzhou	2000	0.38	0.92
Chaozhou	2000	0.39	1.32
Xiantan	2000	0.30	1.10
Nantong	2000	0.32	1.19
Average		0.30	1.04
Yanzhou	1999	0.56	1.73
Jinghua	1999	0.51	1.64
Zhongshan	1999	0.31	1.84
Sanming	1998	0.49	1.72
Weihai	1997	0.64	1.89
Zhangjiagan	2000	0.32	1.89
Dongyin	1999	0.39	1.29
Shangdou	1998	0.42	1.47
Sanya	1997	0.68	1.82
Average		0.48	1.70

Sources: Shandong, Hunan, Anhui, Inner Mongolia, Liaonin, Zhejiang, Guangdong, Hebei, Hubei, Jiangshu, Fujian & Hainan provincial environmental statistical yearbooks1997 – 2000.

Table 3 and Table 4 show that the average environmental investment share in GDP is 2.9% for controlling urban environmental decay in 15 big cities, and 1.7% in 9 medium-sized cities. It is obvious that 1.94% of GDP is not enough for controlling urban environmental decay in big cities, and 1% of GDP is not enough in medium-sized cities. Both are higher than those

estimated by the Chinese scholars earlier. Therefore, we suggest that the necessary environmental investment average for controlling and improving urban environment will be as shown in Table 5.

Table 5 Necessary environment investment for controlling the urban environment

Scale of Cities	The least percentage of GDP for controlling urban environ. decay	The least percentage of GDP for improving urban environment
Big Cities	3.0	3.5
Medium-sized city	2.0	2.5

The emerging question is whether the environmental investments will have a negative influence on economic growth, and thus affect the social progress. To answer this question, the following two issues should be addressed.

The first issue is the costs of environmental damage, defined as natural resources depletion and environmental pollution. Estimating the costs of environmental damage is still in its infancy, but the studies to date have some features in common. In the industrial world, the German data suggests damage costs under 5% of GDP. Dutch estimates are lower (0.5 - 0.8%), but relate to partial effects only. A range of 1 - 5% of GDP thus seems to be a fairly reasonable estimate of environmental degradation in industrial world, and 5% or above in the developing world (Pearce, 1993, 26). Table 6 presented calculation results for some of the Chinese cities.

Table 6 Costs of environmental damage in Chinese cities

Cities	Costs of environ. damages (billion Chinese Yuan)	Costs as a percentage of GDP (%)
Sanming[(1)]	1.5	12.9 (in 1996)
Yantai[(2)]	2.1	9.5 (in 1996)
Qi[(3)]	3.3	12.7 (in 2000)
Ma[(4)]	2.7	11.9 (in 1998)
Ta[(5)]	4.9	14.8 (in 1998)
Wu[(6)]	0.8	14.6 (in 1998)

Sources: [(1) (2)] Cao Fengzhong, et al. (1999:95 and.120); [(3)] Li Keguo (2001: 36); [(4) (5) (6)] Zhang (1999b).

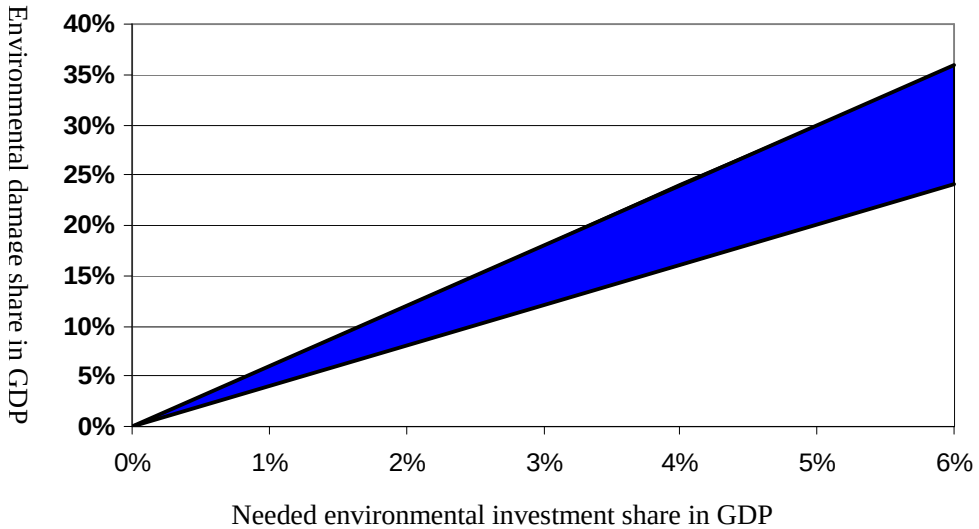

Figure 2 Environmental Damage Vs. Needed Environmental Investment

It seems that the costs of environmental damage sharing in GDP are 10% - 15 % in urban China. When the average necessary environmental investment is 2.5%, the ratio of environmental damage to environmental investment is 4 - 6. The ratio can be shown in Figure 2. The shadow area in Figure 2 is defined as the minimum needed environmental investment vs. the relevant environmental costs. If the environmental costs are foe example 16% - 24% of GDP, 4% of GDP is required for investing in environmental control and improvement.

The second issue is to what extent economic development will decrease because of the environmental investment. This is a controversial issue. On one hand, some of the environmental prevention and treatment programs will have no direct economic profits, but will bring social and environmental profits. In this case, economic growth does decrease. On the other hand, most of the environmental programs, such as recycling waste, decreasing emission by improving the production process and adopting clean technology, will generate not only social and environmental benefits, but also economic profit. In this case, environmental investment will have positive effects on local economic growth.

4. From non-sustainability to sustainability: stages of urban sustainable development

Discussion of transition from non-sustainability to sustainability refers to our fourth issue: can we distinguish the different stages in the development of urban sustainability in China? Although the concept of sustainable development has become a catchphrase since the 1990s, the cases of sustainability or non-sustainability has accompanied human society throughout history. For understanding and evaluating the sustainability degree from non-sustainability to sustainability, we propose a four-stage urban sustainability model within the context of urban China. It is summarized in Table 7.

Table 7 From non-sustainability to sustainability: A four-stage urban sustainability model

Four Stages	Main Characteristic	Possible GDP per capita[4]	Suggested Sustainability Index[5]
Non-sustainability	➢ Serious poverty problem, e.g. percentage of population below the poverty line is 40% or more ➢ The economy is mainly natural resource based, which is characterized by lower value added, backward technologies. e.g. Extracting industries sharing in GDP is more than 50%, and contribution ratio of science & technology to economy is less than 30% ➢ Deterioration of urban structure and performance ➢ Level of investment in reproducible capital has been insufficient to offset the depletion of natural capital, or capital decumulation ➢ There is an apparent tradeoff among economic growth, social progress and environment, or substitution possibilities among economic, social and environmental ➢ Environmental decay is linked to the economic growth. Furthermore, both rates of depletion of natural resources and emissions are more than the economic growth rate ➢ Very poor environmental awareness; and Welfare per capita is stagnant or decreasing.	500USD or less	less than 0.4
Weak Sustainability	➢ Percentage of population below the poverty line is 10% or more ➢ Level of investment in reproducible capital has been sufficient to offset the depletion of natural capital, or an increasing capital accumulation ➢ There is an apparent tradeoff among economic growth, social progress and environment, or substitution possibilities among economic, social and environmental ➢ Environmental decay is linked to economic growth and social progress. However growth rate of emissions is less than the economic growth rate ➢ Poor environmental awareness and a little bit of public involvement in environmental movement ➢ Welfare per capita is increasing	more than 500 USD, but less than 2000 USD	from 0.4 to less than 0.6
Sensible Sustainability	➢ Percentage of population below the poverty line is less than 5% ➢ Environmental decay is decoupling with the economic growth and social progress ➢ Presence of complementarity and tradeoff among economic growth, social progress and environment. However life-supporting ecosystem, especially the fragile ecosystem, or irreversible natural resources is kept intact ➢ stronger environmental awareness, environmentally integrated decision-making, and active public participation in environmental movement ➢ Welfare per capita is not only increasing, but also rationally distributed	2000 USD to 20000 USD	from 0.6 to 0.8
Sustainability	➢ There is no apparent tradeoff among economic growth, social progress and environment ➢ There are balances between renewable resources regeneration and their consumption, and between non-renewable resources consumption and their substitution ➢ Linking of economic growth and pressure on environment ➢ Emissions within environmental purification capacity ➢ A fair, equitable society, and an increasing welfare per capita	more than 20000 USD	more than 0.8

5. Emerging features of environmental management at different stages of sustainability

From this research project, we conclude that non-sustainability is mainly caused by environmental degradation in most of the Chinese cities, and by poverty in the poor cities of China. In both cases, natural resources depletion and environmental degradation are the key signals. The obvious reasons are certainly the economic distortions and insufficient incentives for resource conservation and emission reduction, and the fundamental causes frequently lie in the mismanagement of the urban environment.

For understanding the scope of urban environmental management, especially the linkages between actual urban environmental management activities and urban sustainability are important. We have carried out interviews with employees of the Urban environmental protection bureaus in the four cites. In addition, we also compared the urban environmental management of the Chinese National Environmental Model Cities and other cities (SEPA, 2000)[6]. It is obvious that significant differences in urban environmental management exist in cities that were identified at different stages of urban sustainability. The different stages and their characteristics are summarized in Table 8.

Table 8 Urban environmental management in different stages of urban sustainability

Stages	Principles	Approaches	Law Enforcement	Public Participation
Non-Sustainability	➢ effect-oriented ➢ treatment after pollution ➢ economy first	➢ compartmental ➢ pollution control based ➢ "the end of pipe" approach	➢ very poor law enforcement ➢ most of the enterprises don't comply with the emission standards	➢ poor environmental awareness ➢ Little public participation
Weak Sustainability	➢ both effect and source-oriented ➢ For prevention and treatment ➢ more weights assigned to economy	➢ compartmental and integrated ➢ pollution control based ➢ "command and control"	➢ insufficient law enforcement ➢ large scale companies comply with the emission standards	➢ not enough environmental awareness ➢ some public participation, but quite a number of public complaint
Sensible Sustainability	➢ both effect and source-oriented ➢ paying more attention to prevention; ➢ taking economy and environ. into account	➢ integrated ➢ taking pollution control and ecological conservation into account ➢ safe minimum standards ➢ agreement	➢ efficient law enforcement ➢ non-compliance with emission standards are not allowed	➢ good environmental awareness ➢ active public participation
Sustainability	➢ Both effect and source-oriented ➢ prevention first and zero-emission ➢ putting economic growth, social progress and environment in one package	➢ sustainable ➢ fair and equity based ➢ risk isolating, monitoring and controlling ➢ integrated cycle management ➢ voluntary	➢ efficient law enforcement ➢ clean production and sustainable consumption	➢ good environmental awareness ➢ active public participation

As shown in Table 8, non-efficient management as well as poor integral capacity are linked to non- and weak urban sustainability. Thus strengthening urban environmental management is believed to be one of the priorities for improving urban sustainability.

6. Directions for improving urban sustainability in China

Before proposing directions for improving urban sustainability in China, it is necessary to identify a number of empirical cause-effect relations related to weak or non-sustainability. Our findings with regard to this cause-effect relations are shown in Table 9.

Table 9 Cause - effect relations of urban non-sustainability

Causes	Effects	Examples
1. Poverty	➢ ill health ➢ social stress ➢ poor education and unskilled labor force ➢ deforestation and other ecological destruction ➢ unsustainable uses of natural resources ➢ environmental degradation	Cities in the poor areas. e.g. cities in the West part of China
2. Poor environmental awareness	➢ economic development are top priority ➢ insufficient integrated decision-making ➢ inadequate environmental concerns ➢ few public environmental participation	Cities such as Ta, Wu
3. Slow structural adjustment	➢ natural resources based industry and lower efficiency of consumption of resources ➢ lack of potential economic growth ➢ higher emissions ➢ slow quality improvement	Cities in the North part of China
4. Poor sectional coordination	➢ each does its own thing ➢ poor cooperation ➢ lower working efficiency; ➢ non achievable sustainability ➢ unsustainable development	Common issue in most Chinese cities
5. Poor institutional capacity	➢ corruption ➢ strong public complaints ➢ unbalance equity for stakeholders ➢ lower working efficiency ➢ lack of potential for further development ➢ mismanagement	Common issue in most of Chinese cities
6. Limited financial resources	➢ increasing environmental decay ➢ increasing ecological destruction;	In the cities where GDP per capita is 1500 USD or less
7. Poor technological capacity	➢ poor treatment capacity and increasing emissions ➢ backward production technologies ➢ lower efficiency in the use of natural resources	Also in the cities where GDP per capita is 1500 USD or less
8. Lack of environmental sound incentives	➢ lack of environmentally safe technologies ➢ unsustainable policies ➢ increasing environmental pollution and ecological destruction ➢ non environmental sound market mechanism	Common issue in most Chinese cities, esp. in the poor areas

Based on the discussion in Table 9, directions for improving Chinese urban sustainability are

presented below.

6.1 Stimulating environmentally friendly programs for alleviating poverty

For achieving sustainability, it is recognized that the top priority should be given to raising the living standard of population and to alleviation of poverty. However, national traditional poverty-alleviation programs were focused on local natural resource extraction and technical assistance disregarding to the quality of the environment. In the 1970s, national poverty-alleviation programs were simply providing food to people below the poverty line. This policy has not achieved its goal, but has resulted in the expansion of poverty. The common consequence of this policy is that people in the poor areas become idle, and local authorities do not care to create new jobs, but just wait for aid from central government. Since the 1980s, national poverty-alleviation programs have moved to institutional capacity building by providing financial and technical support. As a result, the establishment of local small industries based on natural resources has grown fast, and the population below the national poverty line has substantially decreased. However, a large amount of pollution-producing industries have been transferred to these areas from the developed cities. Our case study has also indicated that pollution-type industries in Taizhou, such as the chemical industry, were mainly transferred from Shanghai where these enterprises faced closure as a consequence of the stronger environmental requirements in that area.

Alleviating poverty is very important for achieving sustainability, but it is more important to protect the life-supporting system. China is developing the economy in the western part of the country (largest poverty area). However, in the process, pollution causing industries are encouraged to move from the eastern part of the country to the west. Consequently, there is a threat that unsustainability may be transferred from eastern China to western China. Therefore, stimulating environmental friendly programs in alleviating poverty as well as in the development of western China will have a significant influence on national sustainable development. Environmental considerations should be taken into an account in each of the poverty-alleviation programs.

6.2 Raising environmental awareness, in particular the decision-maker's awareness

It was also identified that low environmental awareness is closely linked to poor environmental management, and, thus, to weak or non-sustainability. Qu (2000), the former director of State Environmental Protection Administration, has argued that the key bottleneck of China's environmental protection is not the limited financial technical resources, but the low environmental awareness.

There is obviously a need to raise general environmental awareness. Improving public awareness is required not only for public concerns, but also for public participation in environmental activities. Raising public environmental awareness should focus on ecological ethics, green consumption and active involvement in environmental improvement. Raising policy-makers' awareness is particularly important since it could lead to the formulation of

environmentally efficient standards and sound policies for enforcement. Policy-makers could also provide various incentives for those willing to protect the environment.

For raising awareness, access to environmental information is required. Mass media can play the central role, and government and NGOs should cooperate to initiate environmental training and communication programs. Enforcing interactive environmental education is also important in the primary and secondary schools.

6.3 Promoting economic structural adjustment

As we have discussed before, urban non-sustainability is likely to start with structural decline. The slow implementation of economic structural adjustment policies is not only the cause of urban environmental degradation, but also leads to a loss of urban competitiveness. This program showed that weak or non-sustainability frequently appeared in the cities where economic structural adjustment was going slowly.

In most of the Chinese cities, the economy is characterized by higher industrial output value and lower value-added. The main contributors of GDP are the primary and secondary industries. The share of tertiary industry in GDP is only 34%, much lower than the 80% in the developed world (Niu, 2001). Economic structural adjustment has become one of the top priorities for national economic sustainability.

6.4 Improving cross-departmental coordination

This research program showed that there are clear signs that government agencies are not sufficiently prepared for the cross-departmental task of improving sustainability. Absence of coordination among different agencies can mean potential threats to the efficient use of local resources and local sustainable development. Improving cross-departmental coordination and looking for ways to harmonize ecological, economic and social challenges are crucial for achieving urban sustainable development.

To improve sectional coordination, it is urgently needed to reform the administrative system. The national government is trying to do this, and has achieved part of the goals at national level. However many problems still exist at the provincial and urban level. From the point of view of sustainable development, this reform, which is focused on reducing official departments and employees, is not enough. The in-depth reform should take the following issues into account:

- Re-identifying responsibilities of urban departments within the requirements of sustainability, and trying to find a way for implementing integral management approach;
- Reforming the traditional administrative system, which is planned economy based, and establishing the new system, based on market economy;
- Stimulating the different urban actors to be involved in urban management; and
- Inputting innovative ideas into the new administrative system.

6.5 Enforcing institutional capacity building

Poor institutional capacity is obviously linked to weak sustainability, and, therefore, enforcing institutional capacity building is crucial to the achievement of urban sustainability. Urban institutional capacity is the ability to establish co-operation among urban stakeholders involved in urban management, and the most successful institutional process has to be participatory (Van Dijk, 2006).

To improve urban institutional capacity in China, the following issues must be taken into account:

- reforming the current urban administrative system;
- providing training to government officers;
- enabling availability of information;
- stimulating public participation; and
- increasing accountability, transparency and efficiency.

6.6 Providing financial and technical incentives

Financial and technical incentives for improving urban environmental sustainability are likewise needed. A set of possible financial incentives includes free use of land, tax and subsidies. In this regard, there are successful experiences from big cities. For example, for investing in urban sewage treatment, free use of land could be possible within 20 years for investors. There are also favorable financial incentives for foreign capitals, such as providing a tax subsidy for the first five years. Government should be active in providing subsidies for supporting environmentally friendly programs, such as ecological construction projects and urban environmental improvement projects.

Technical incentives include the provision of research and development of pollution control facilities to polluting industries, and to encourage environmental technology development at research institutes and universities. Co-operation between the existing technical institutes and industrial sectors is particularly needed. Access to green technologies and good urban environmental management is also important. It is suggested that an urban sustainability information network should be established, in which, advanced environmentally sound technologies as well as best practices on improving urban sustainability are available.

6.7 Reforming urban environmental management

As we have argued before, urban environmental degradation is a key sign of urban decline. There are many reasons related to urban environmental degradation, however the fundamental reason is mismanagement. From the survey, we were daunted by the weak urban environmental management in China. In most Chinese cities, for example, there are more than 20 agencies under the urban municipality but the environmental protection bureau is always considered to be in a weak position.

The traditional Chinese urban environmental management is facing two big challenges. One is

that Chinese urban environmental administration is based on a planned economy. The challenge is how this kind of administration can be adjusted to the new transition economy, which is from planned to market, and in particular, China's entry to the World Trade Organization (WTO). The other one is that the command-and-control based Chinese urban management approach is being challenged by the new trends in international agreements and of volunteer-based urban environmental management approaches. Thus, there is an urgent need for reforming Chinese urban environmental management system.

6.8 Building urban sustainability information systems

For achieving urban sustainable development, knowledge-based integrated decision-making, public participation and consensus-oriented dialogue are crucial, and sustainability information systems are a precondition (Van Dijk, 2001). It is expected that efficient information systems can provide scientific support in the following ways:

- reliable access to information at the right time and at the right cost;
- providing information that urban sustainability is improving or declining;
- providing an evaluation base for urban activities in which positive or negative responses of urban sustainability could be identified;
- tools to transform collected and analyzed data and indicators into usable information or integrated indices for relevant stakeholders and decision-makers; and
- providing the basis for identifying weak - strong points of urban sustainability in a specific period.

It is obvious that the development of urban sustainability indicators system, which could meet the different requirements of urban actors and different objectives, will play the central role in the establishment and performance of the urban sustainability information systems. This is also the expectation of this research program. A recent positive development is that Qinhuangdao, one of the case cities in Zhang (2001) is already in the process of establishing its sustainability information system. One of the outputs of this system will be the annual report on urban sustainable development, which will be made available to all the urban stakeholders.

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Notes

[1] HOVO Rotterdam, January 24, 2008. An earlier version was presented at Presented at the Second International conference on environmental concerns October 12-15, 2004 in Xiamen, China.

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[4] Based on the context of urban China.

[5] Based on the urban sustainability index developed by this research project.

[6] With the principle of voluntary participation, various cities will examine their basic situations on environmental management, using the indicators developed by SEPA for examining the national environmental model cities. Upon their application, SEPA will organize a panel review and examination and collect comments from various sectors and the public. Accordingly, SEPA will or will not award the city the title of "National Environmental Model City". So far, there are eleven cities that have been awarded with the title.