LUMES – Lund University International Master's Programme in Environmental Studies and Sustainability Science

Controlling Municipal Solid Waste (MSW) Over-generation with a "Waste Disposal Fee" Based on an Efficient Stakeholder Partnership

--a case study in the old city of Ningbo

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ABSTRACT:

Municipal solid waste (MSW) generation is expanding rapidly during the last decades in China; however, most Chinese cities have great pressure on acquiring the capacity to cope with this escalating amount of waste. This paper explores a case study in the old city of Ningbo in China. The purpose of the paper is to examine how the introduction of a “waste disposal fee” based on a stakeholder partnership can be effective in controlling MSW over-generation in the area. The paper uses one strategic management approach, namely the DPSIR framework to analyze the causality behind MSW over-generation problem by penetrating into the complicated interaction among various stakeholders involved in the overall MSW management system. Hägerstrand’s nested spatial domain system is adopted for analyzing and improving stakeholder partnership in MSW management system both vertically and horizontally. The paper concludes that efficient stakeholder partnership is a precondition for the implementation of “waste disposal fee” to control MSW over-generation in the old city of Ningbo. Both pros and risks can exist with the adoption of “waste disposal fee”.

Keywords: Municipal solid waste (MSW), waste over-generation, DPSIR, Hägerstrand’s spatial domain system, the old city of Ningbo, stakeholders, waste disposal fee,

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ACKNOWLEDGEMENTS

I sincerely thank Barry Ness for his great help as a thesis supervisor. His generous counsel has hugely helped me accomplish this paper.

I would also express my thanks to every LUMES teacher, Ingegerd, Åsa, Harald, etc.

Special thanks to my dear fellow classmates who have been inspiring me throughout the whole study period and the thesis writing.

Lastly but not least, I must thank my parents to support me everything since I was born.

1. INTRODUCTION

The unprecedented economic development which has taken place in mainland China during the last two decades has largely improved Chinese peoples' living standards and significantly increased the abundance of the products in the market. However, the high priority on economic development, especially at the earlier stage of the economic reform, promoted by the Chinese government has also had lasting implications on the environment in China. A new emerging environmental challenge is how to properly handle the rapidly growing quantity of Municipal Solid Waste (MSW) produced through daily life. It is estimated that two-thirds of the Chinese cities are now surrounded by the domestic refuse heaps (Beukering *et al*. 1997). This is mainly because of a lack of allocated waste treatment money as well as inefficient stakeholder coordination and cooperation within the MSW management system.

Many environmental protection efforts, mostly reflected by the introduction of a comprehensive environmental legislation, have been made because of the awareness toward the detriment of the environment in the last decades, among which *Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste* was enacted in 1995. However most of the municipalities in China are still facing the great challenge of how to properly handle the large quantities of waste generated everyday with a low stakeholder partnership concerning MSW management (Fung 2000). The huge amounts of MSW with a wide waste composition not only demand a higher standard of the waste management technologies, but also become a serious challenge to the public service ability of the municipalities.

Ningbo, with a population of approximately 5.46 million and an area of 9,365 km², is located in southeast China, along the coast.[1] The old city of Ningbo, with approximately 1.7 million inhabitants, consists of six districts—Haishu, Jiangdong, Jiangbei, Beilun, Zhenhai and Yingzhou (Ningbo Statistics Bureau, 2003). In this paper, the MSW management system in the old city of Ningbo is selected as the main focal point for the case study. This is because that as a coastal city, Ningbo has an important leading position in the whole country's economic development and, that MSW produced daily in the area are also increasing rapidly.

Currently, landfilling and incineration are the two major waste treatment methods for the MSW handling in the old city of Ningbo. However neither of them can totally meet the needs of the huge quantities of MSW generation. Landfilling is the most common way for handling MSW, but the two landfilling sites in the area have neither gas control system nor leachate collection system. In addition, landfilling sites have to occupy a great amount of land area. There is only one incineration plant—Fenglin

[1] The figure of population is from the year of 2002 and includes all people living in Ningbo city. Ningbo: http://www.ansers.com/topic/ningbo accessed 15 March, 2007.

incineration plant—operating for dealing with the waste from the old city of Ningbo. The incineration plant has a small capacity of waste handling, requiring a manual sorting and a manual loading of the waste, and the environmental consideration is insufficient. Since 1st October, 2006, the Municipality Sanitation Bureau (MSB) introduced a third way of treating MSW in the area--waste composting system. Information and data on the new composting system are still not available at the moment due to a short time of running. Generally speaking, the overall MSW handling efficiency is rather low in the old city of Ningbo, particularly reflected by the insufficient capacity of handling the rapid escalating MSW.

1.1. Aim & research design

The purpose of this paper is to examine how the introduction of a waste disposal fee, based on an improved stakeholder partnership, has the possibility to be effective in controlling MSW over-generation in the old city of Ningbo. The paper will address two inter-related problems: one is how to enhance the stakeholder partnership within the overall MSW management system—the prerequisite for the implementation of the waste disposal fee. The other is to evaluate if the goal of waste minimization in the old city of Ningbo can be obtained through the introduction of a waste disposal fee. MSW over-generation is a complex issue and various drivers have contributed to it, however, the analysis in the paper will only address one particular driving force (economic development), its related pressures, state and impacts. Good solutions are needed to reduce the negative impacts that waste over-generation brings to society and the paper also brings the idea of the adoption of a waste disposal fee to keep waste over-generation under control in the old city of Ningbo. Efficient stakeholder cooperation and coordination within the overall MSW management system is significant, particularly when activities, such as the collection and the distribution of waste disposal fee, are involved. The paper will be formulated under the following structure:

- Section 1, the general background and the case study, the aim of the paper and the methods applied, along with the thesis scope and limitation will be addressed.
- Section 2, the current situation of waste generation, waste composition and components, waste developing trend will be presented;
- Section 3, by using DPSIR framework, the waste over-generation problem in the old city of Ningbo will be conceptualized based on the analysis on one source of the driving forces, confronting pressure, state, and impacts. The recommended response policy toward waste over-generation will be explored more in section 4.
- Section 4, response proposal (a recommended “fee” solution) will be investigated and analyzed with the consideration of the particular situations in the old city of Ningbo;
- Section 5, the current MSW management structure in the old city of Ningbo will be given;

- Section 6, the implementation of policy response, e.g. waste disposal fee relies significantly on an efficient and concrete stakeholder partnership in the MSW management system, with Hägerstrand's spatial domain system, key stakeholders & their current low working efficiency and partnership, both vertically and horizontally, concerning MSW management system in the old city of Ningbo will be explored and reviewed; the limited stakeholder working partnership will be re-allocated and re-organized in the paper;
- Section 7, conclusion will be drawn.

1.2. Methods

Several methodological approaches are used in the research. The background literature reviews and the case study constitute the major base for the paper. Yin (2003) claims that case study can enable the investigators to "retain the holistic and meaningful characteristics of real life events". In addition, the case study is also complemented by an interview with Changpei Fang--the director from Ningbo Sanitation Bureau and the interviews with households in the old city of Ningbo. The interviews[2] with local households are the major sources that form the hypothesis of the implementation of a "waste disposal fee" to minimize MSW over-generation in the old city of Ningbo in this paper. Field trips to Fenglin incineration plant and the landfilling sites are developed with respect to the different purpose within the project. The results from the interviews and field trips are presented and integrated later in the paper.

DPSIR framework, which stands for Driving forces, Pressures, State, Impacts, and Responses, is used to gain a holistic understanding of the associated driving forces and the resulting impacts and thus, bring out the cause-effect relations in the MSW over-generation in the area. Additionally, Hägerstrand's system of nested spatial domain which can assess interactions among each level of the stakeholders and their actions is also used to analyze various stakeholders' involvement from different spatial levels in the complicated MSW management in the old city of Ningbo (Hägerstrand 2001).

1.3. Scope & limitation

The MSW generated in Chinese cities include three categories: household waste (67.5%), waste collected from the street-cleaning (11%) and institutional waste (21.5%)[3] (Fung 2000; He *et al* 2004). This paper only focuses on the MSW generated from inhabitants' daily life in the old city of Ningbo (often referred to as *household*

[2] Twenty interviews with the local households were carried out. The main interview question is "which measure do you think can be taken in controlling MSW over-generation effectively in the old city of Ningbo" and approximately two thirds of the households proposed the adoption of a "waste disposal fee".

[3] Institutional waste here refer to those waste collected from shopping farcades, small industrial workshops in densely-populated commercial centers and establishments and offices.

waste). Therefore, industrial waste, medical waste, construction waste, etc are excluded from the paper. Further, hazardous waste, (e.g. batteries,) belongs to MSW; however there is no particular space in the paper for the analysis of specific hazardous waste rather a general classification will be made. Furthermore, in the paper, the MSW is taken as a whole unit for analysis which means there will be no specific analysis for the various kinds of waste.

One limitation of the paper can be caused by the inadequate data and figures collected due to a comparatively under-developed and inconvenient procedure for collecting MSW data by the local municipality in Ningbo. Moreover, there are several categories of stakeholders involved in the MSW management system and the coordination and cooperation efficiency among them are rather low which make the data collection more difficult. Even with those figures and data acquired, there is a great disparity among different opinions in the interviews. Thus, the figures and waste data cited in this paper can not be 100% reliable. This partly reflects and explains the current complicated waste management situation in the old city of Ningbo. Lastly, the recommended "fee" solution can create insufficient results since it only directs back to the pressure stage of the waste over-generation problem.

2. BACKGROUND

2.1. MSW generation in China and the old city of Ningbo

In recent years, the output of MSW has been steadily increasing in mainland China. At the moment, the total amount of MSW generated in mainland China is 106,710,000 ton per year and 1.58 kg per capita per day (SEPA 1998a; Environmental Protection Bureau of China 1995; Zhou & Yu 1997). Certainly, there is a considerable variation in waste generation amounts throughout the whole country as a result of diverse local economy, population density and demographic characteristics of the population, etc (Hockett *et al* 1995). It is documented that the annual increase rate of the MSW generation has been up to 9% within the whole country (Table 1) (SEPA 1998a; Environmental Protection Bureau of China 1995; Zhou & Yu 1997). It is estimated by Environmental Protection Bureau of China that since the year 1999 the total amount of MSW produced from urban inhabitants has exceeded 150 million tons in mainland China.

From 1998 to 2002, the total amounts of MSW generation and MSW generation per capita per day in Ningbo[4] have also increased steadily each year (Table 2) (Ningbo Statistics Bureau 2003; He, *et al* 2004). According to the interview with Fang, the director of Municipal Sanitation Bureau (MSB), the MSW generation reached 2 kg per capita per day in the old city of Ningbo in 2005, which is higher than most of the

[4] Ningbo here refers to the greater Ningbo area.

OECD countries except the US (Table 1). The MSW increase rate is expected to rise at around 20% per year in the old city of Ningbo.[5]

Table.1 Municipal Solid Waste generation in the selected OECD countries & China. [6] ***(Adapted from Fung 2000)***

Countries	***Total amount generated (1000 tons)***	***Per capita per day (kg/capita, day)***
USA	187790	2.00
Canada	18800	1.81
France	27000	1.29
Japan	50767	1.12
Denmark	2377	1.10
Sweden	3200	1.01
Germany	28401	0.99
China*	106710	1.58

*Figure of the total quantities of generated MSW for China is the summation of both household waste and the waste collected from the streets and the public institutes. The household waste accounts for approximately 65% of the total waste collected in China (Source: Environmental Protection Bureau of China, 1995).

Table.2 MSW generation in the old city of Ningbo from the year 1998 to the year 2002. (Adapted from He, et al 2004)

Year	**Total amount generated per year (1000 tons)**	**Average amount generated per day (ton/day)**
1998	32.3	883
1999	35.7	997
2000	37.8	1037
2001	44.6	1222
2002	56.4	1546

2.2. MSW components and composition in the old city of Ningbo

Chung and Poon (2001) argue that the analysis and understanding of MSW composition and waste characteristics are essential for "the formulation of the waste management policy", "the planning of the waste disposal facilities" as well as "the designing of the pollution control measurements." However, studies in this area are

[5] Figures are acquired from the interview with Chang-Pei Fang, the director of Municipal Sanitation Bureau (MSB).

[6] Figures for China is from SEPA 1998b (table 3) for the year 1995; all other figures are from OECD 1995, table 7.2A; data on Sweden and Germany are for the year 1990 and others are from 1992. Ningbo refers to the whole geographical Ningbo city which includes the old city of Ningbo and the surrounding counties, towns and villages.

rarely carried out in Chinese cities both because of the lack of the funding to carry out the studies, and insufficient awareness toward MSW issues among national and local governments.

According to the Ningbo Statistics Bureau (2003), from 1998 to the year 2002, organic components (food scrap), which weigh the most among the total MSW produced in the area, account for approximately 65%; inorganic components (e.g. furnace ash, brick, tiles & stones, dust & ash, glass, metal, etc.), account for the 35% remain. Waste that can be recycled (paper, plastic, glass, metal and textile, etc.) account for approximately 30% (Table 3 & Table 4). Also, the figures show that there is a decreasing trend in the inorganic composition (mainly dust and ash),[7] while there is a significantly increase of 74.8% in plastic waste produced in the area (Table 3). A high organic composition with a relatively low heat value is the two major characteristics of the local MSW (Lin 2002; He, *et al* 2004).

Table.3 MSW composition in the old city of Ningbo from the year 1998 to the year 2002. (Adapted from Ningbo Statistics Bureau 2003)

Year	Paper	Plastic	Textile	Glass	Metal
1998	7.85	10.30	4.36	3.43	2.91
1999	6.77	13.10	2.97	4.63	0.50
2000	8.53	15.50	2.90	3.35	0.50
2001	8.20	15.60	3.50	3.30	0.60
2002	5.11	18.00	4.90	2.52	0.85

Table.4 MSW composition in the old city of Ningbo from the year 1998 to the year 2002. (Continued from Table 3) (Adapted from Ningbo Statistics Bureau 2003)

Year	Bamboo & rattan	Food scrap	Inorganic components
1998	3.82	46.20	21.10
1999	0.27	50.80	20.90
2000	1.00	47.60	20.60
2001	2.20	48.40	20.20
2002	2.71	45.90	18.60

2.3. MSW generation trends in the old city of Ningbo

Based on Ningbo municipality's comprehensive layout of the population and economic development index for the next 15 years, the expected MSW generation amounts per day and the total amounts of MSW generated in the old city of Ningbo in the year 2010 and 2020, respectively, can be seen in Table 5 (Ningbo Municipality

[7] The reduction of dust and ash is mainly due to the shift from coal to gas for cooking; hot water, etc. therefore, this significantly reduced the coal ash proportion in the household wastes.

Bureau, 2003). The fast escalating quantities of MSW generation has created great pressure on the local municipality and thus, a proper method to minimize waste over-generation is required.

Table.5 The expected MSW generation in the old city of Ningbo.[8]

Year	**Population (m)**	**Amounts per day (t)**	**Total amounts per year (1000t)**
2005	1.7	1870	68
2010	2.0	4400*	160*
2020	2.6	5200*	190*

*The amounts of MSW generation in the old Ningbo city per day and the total amounts per year are calculated based on the assumption that the average amounts of MSW generation per person is 2 kg per day in the year 2010 and 2020. From 2000 to 2005, the average amount of MSW generation per person per day was assumed as 1.1kg in the old city of Ningbo.[9]

3. CONCEPTUALIZING MSW OVER-GENERATION FACTORS USING A DPSIR FRAMEWORK

3.1. DPSIR framework

A thorough understanding of the problem of waste generation in the old city of Ningbo, its related driving forces and resulting impacts at various levels are essential before problem-solving efforts are taken. Many methodologies, e.g. causal loop diagramming and DPSIR framework can be applied to depict the problem. DPSIR stands for Driving forces, Pressures, State, Impacts, and Responses (**Fig.1**). Pressure-State-Response (P-S-R) framework launched by Organization for Economic Cooperation and Development (OECD) provides a base for the emerging of the current DPSIR model. Its major application is on assessing and managing the environmental problems, especially climate change, water issue, etc, therefore is useful for policy-makers. Besides, with DPSIR framework, all related parts within the system, e.g. driving forces, pressures, state, impacts and responses together with their inter-collected causality can be discovered and identified. The ultimate goal of DPSIR framework is to evaluate the effectiveness and efficiency of the policy responses (EEA 1999).

[8] Figures from 2005 are adapted from He, *et al*, 2004; all other figures are calculated based on the assumption of 2kg per day per person by the author.

[9] According to Fang, the director from Ningbo Sanitation Bureau, the assumption of 1.1kg was made by the municipality in the year 2003, therefore, the number is much lower than the current 2kg MSW generation per day per person in the old city of Ningbo.

In short, *driving forces* refer to the external forces (e.g. social, demographic and economic etc) which can influence human activities (e.g. life style). *Pressures on the environment* are the consequences that the change of human activities can bring on the environment. *Pressures* can be either increased or mitigated under the function of the external forces. *States* mirror the pressures and are the reflections and conditions of *pressures* on the environmental status, usually in a quality perspective. *Impacts* are the effects after environmental degradation. *Responses* are the feedback and actions from society with attempt to prevent, compensate or change the previous problems. The responses can become new pressures overtime and the effectiveness of responses can be directed back and examined to any of the four previous indicators. In general, taxes, fees, regulations are the most common form of responses existed (EEA 1999; UNEP 2002). However, DPSIR framework is traditionally criticized for a mechanistic oversimplification of the scheme, scheme linearity and the difficulties in encompassing the multi-scale and multidimensional relationships of the environmental problems. Additionally, DPSIR framework also has the deficiency to handle the policies which can act both as a driving force and response (Klijn 2004).

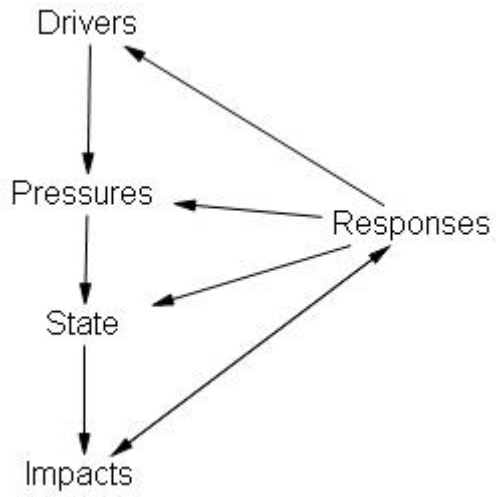

Fig.1 Conventional DPSIR scheme. Drivers refer to the external forces. Pressures are the consequences of the driving forces. States mirror the pressure. Impacts are the resulting effects. Reponses are the actions from society.

3.2. Conceptualizing MSW over-generation with a DPSIR framework

Environmental phenomena often overlap various spatial levels (Grainger & Purvis 2004). A number of variables (some of them are inter-related) can be found to be positively correlated with waste over-generation in the old city of Ningbo, such as demographic factors (e.g. disappear/declining of the average household size and a quick growth of new households) (Parfitt 2002; Jenkins 1993). Population increase is another overwhelming variable influencing total waste generation (Hockett 1995). Income and consuming expenditure resulted from economic development leading to the increase of post-consumed waste (Chang *et al* 1993) while Rthje & Murphy (1992)

claims null correlation has been found. The fast regional or national urbanization process and affluence intensified the waste over-generation problem. At the meanwhile, a negative correlation can also be found between population density and waste generation as well as between public awareness toward environment and waste generation (Jenkins 1993).

Therefore, numerous DPSIR frameworks can be used at different levels of the defined problem with a number of driving forces specified. However, due to the space limit, this paper will only focus on the economic growth as one key driving force for the waste over-generation in the old city of Ningbo. **Fig2** shows a simple DPSIR model for one source of waste over-generation in the area.

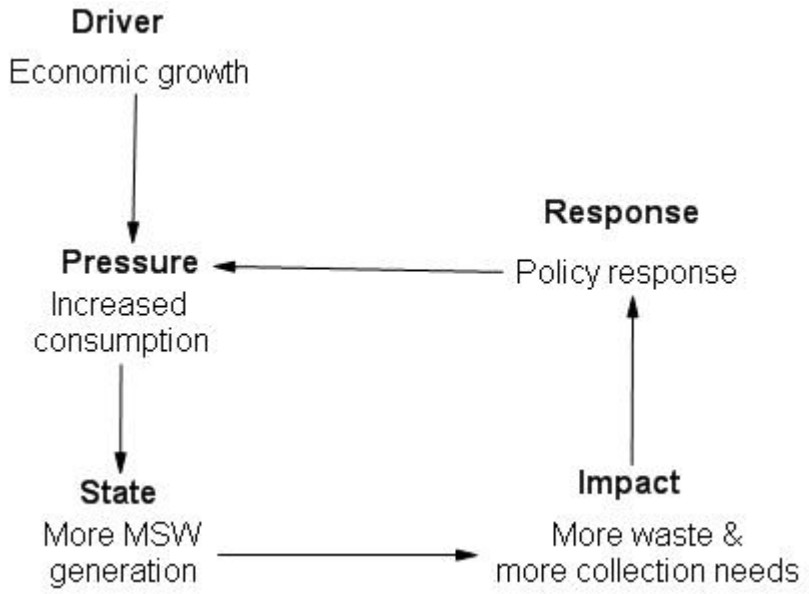

Fig.2 DPSIR scheme for waste over-generation

According to the preliminary statistics from 2004, GDP in Ningbo amounted to 215,804 billion RMB,[10] increasing by 15.5%, compared with 2003 (Statistics of National Economy and Social Development of Ningbo 2004). The increasing household consumption expenditure is one consequence of the driving force—economic growth. The increasing economic growth results in a growing dispensed income, which consequently leads to a rising household consumption. In 2004, the level of urban inhabitant's consumption expenditure in Ningbo was 2.7% higher than 2003 (Statistics of National Economy and Social Development of Ningbo 2004). Fung (2000) argues that the total quantities of waste generated in China have a high correlation coefficient of 0.95 with per capita urban household expenditure. The increasing household consumption has led to an increase in the generation of household waste, leading to an excess of waste in the area. A variety of policy responses toward waste over-generation problem can be made, among which, to

[10] RMB is the Chinese currency; one RMB is almost equivalent to one SEK.

impose a waste disposal fee is recommended in the paper to minimize and control waste over-generation in the area and an efficient stakeholder partnership is of great significance to ensure the working of the "fee" solution (the analysis on the adoption of a waste disposal fee will be developed more in section 5). However, this "fee" solution may cause insufficient results later since it only directs back toward the pressure stage instead of the driving forces.

The already large, however, still rapidly growing MSW generation has given rise to many problems. At present, the local solid waste management can no longer meet the excess demand for proper waste disposal which creates a backlog of MSW left in the urban environment. Ningbo, like most of the cities in mainland China, with a relatively good economic development but intense living areas, is very dependent on the waste incineration rather than landfilling to treat the waste. Incineration of the MSW is encouraged and supported by the local municipality both because of a limited landfilling sites and a need for electricity generation through burning the waste. In the year 2002, the waste treatment capacity of Fenglin waste incineration plant was 72% of the total MSW generation in the old city of Ningbo. This incineration plant can treat at most 1,000 tons per day[11] but the MSW generation in the old city of Ningbo has exceeded 1,200 tons per day. From March 2003, the rest 200-300 ton extra waste has to be transferred to the surrounding landfilling sites every day or even worse, a part of the waste are dumped untreated, posing more dangers to the environment, e.g. water pollution from the leaches of the food residue, land contamination of heavy metals, natural resources degradation, etc; an unpleasant visual pollution[12] along with a foul smell; the spread of communicable diseases threatening local inhabitants' health; a breeding cradle for flies and mosquitoes; and it also occupies the scarce and limited productive land[13] (Taylor 1999).

The cost for MSW treatment is also rapidly increasing. The cost of MSW treatment can range from 0.5 to 2% of the total GDP, and 20 to 50% municipal budget goes for the MSW handling in developing countries (Serageldin *et al.* 1995; Cointreau-Levine 1994; Douglass & Lee 1996; Schubeler, 1996). Therefore, the expensive MSW management expenditure has brought great pressure on local finances.

What is more, a quarter of Chinese cities are facing the serious issue of treatment and storage of the increasing quantities of MSW, currently they are transferring urban MSW to rural areas to ease the pressure upon urban infrastructures, this creates new environmental, social and economical problems for these rural areas (Zhu 2005).Thus, it is necessary to take sufficient short- and long-term actions to enhance the current MSW management system in China and make waste management a 'sustainable use of resources'.

[11] The real waste treatment capacity of Fenglin incineration plant is 900 ton per day.
[12] According to the definition from SEPA, visual pollution refers to an unpleasant feeling caused by seeing the MSW heaps at public places.
[13] The yearly accumulated MSW in China has already occupied approximately 0.5 billion square meters land.

4. THE INTRODUCTION OF A WASTE DISPOSAL FEE FOR CONTROLLING & MINIMIZING WASTE OVER-GENERATION IN THE OLD CITY OF NINGBO

4.1. The developed DPSIR model & an overview of economic instruments

The traditional policy response toward MSW over-generation is usually a top-down legislative framework, which is inflexible and can not provide sufficient incentives for the local stakeholders to reduce waste generation. In this paper, a "fee" solution is recommended to minimize waste over-generation in the old city of Ningbo.

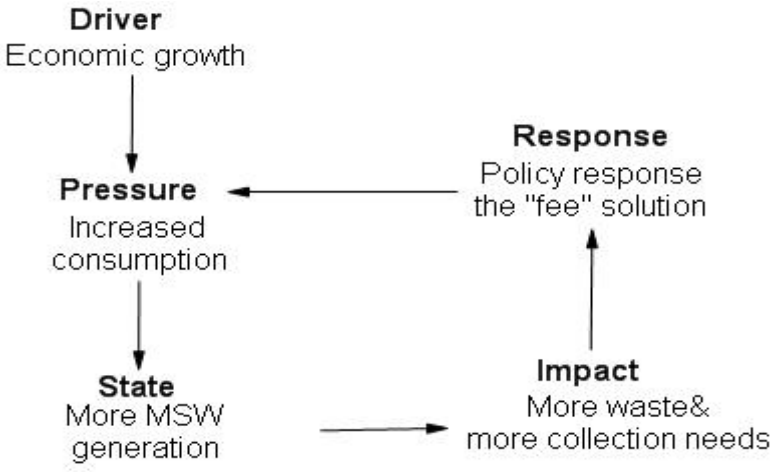

Fig.3 DPSIR scheme with the introduction of the "fee" solution

Economic instruments, together with direct regulations/command-and-control approaches and suasive instruments are the three generally classified instruments composing environmental policy instruments. OECD defines economic instruments as "a means by which decisions or actions of government affect the behavior of producers and consumers by causing changes in the prices to be paid for these activities" (OECD 2005). Environmental charges, e.g. waste disposal fee and taxes, deposit/refund system, etc. are the most common forms of economic instruments designed to influence people's behaviors (Naturvårdsverket 2005).

The evolution and emergence of economic instruments have undergone mainly three stages. Arthur Pigou (1920), a British economist, was the first person who formalized and proposed a Pigovian tax on pollution (the tax was named after him) to correct the negative externalities from a market activity and internalize the full social costs including all sorts of environmental damage, e.g. pollution, resource exploitation, etc (Fullerton & Mohr 2003). In 1972, OECD launched "Polluter-Pays-Principle" which places a "price" on the negative impacts of the pollution and enforces the polluters to pay the cost created on our society (OECD 1975). The principle internalizes the waste management awareness and responsibility into the particular polluters through an

economic instrument and provides polluters with an incentive to alter the decision and behaviors. Thus, the principle can directly and effectively influence the decision-making process and public behavior and bring a second consideration on using the scare environmental resources rationally (OECD 1994). In 1992, the United Nations Conference on Environment and Development (UNCED) in Rio de Janeriro is the breakthrough for the adoption of economic instruments in managing environmental problem. The Agenda 21 raised the necessity to integrate social, economic and environmental factors in a broader scope to achieve sustainable development and defines the need of using economic instruments and other incentives for natural resource management and pollution control (UNCED 1992a; UNCED 1992b).

4.2. The practice of economic instruments for minimizing waste over-generation in the international dimension

The reference studies on the experiences from the US and the EU shows that waste prevention and reduction should always be preferred than other MSW treatment methods and thus, ranked on the top level of MSW management hierarchy (EU 1999; USEPA 1995). Economic instruments, especially direct waste disposal charging and environmental tax have been widely adopted in the US and several EU member countries to promote waste minimization and reduce the waste for final disposal[14]:

- more than 4,000 communities in the US are now charging direct “fee” to household waste management;
- France has a “subscription fee” for each household;
- Denmark charges double for additional bins if the household waste exceeds the provided 190 litre bins in Åahus; in Mid-Jutland, annual waste disposal fee is charged from the households;
- Germany charges the waste fee depending on the number of containers, size and frequency of waste collection;
- Finland has been promoting a waste tax for obtaining a high recycling rate on specific waste streams

4.3. Pros of the introduction of a waste disposal fee

The increasing population, afflux and industrialization intend to show a low potential of waste generation reduction in the old city of Ningbo and the underdeveloped waste separation system brings a low efficiency on waste recycling and recovery. Theodore (1993) argues that for countries with limited resources, economic incentives can be the significant approaches to obtain the desired environmental effects since they have the least cost; in the meanwhile, will not compromise countries’ competitiveness in the world market. Therefore, a better use of the existing local resources and public

[14] source from International Comparisons of Economic Instruments for Waste Management Accessed 6 May. 2007.

support appear to be more realistic and practical in preventing and controlling the MSW over-generation. Comparing with traditional highly centralized planning and implementing legislative and regulatory provisions, waste disposal fee possess more virtues if they are properly developed and implemented.

The most prominent advantage of the adoption of a waste disposal fee is that based on the market mechanism, the environmental concern and the full costs of environmental damage caused by waste over-generation can be internalized and directly influence the decision making process and public behaviors to reduce or stop of such damage and move toward an environmentally more desirable target as well as to ensure the leverage of the prices for the rational utilization of environmental resources and emphasizing environmental protection (OECD 1994; Turner *et al* 1994). The implementation of a waste disposal fee can thus, have an incentive impact on individual households "at least to the level where the marginal cost of pollution reduction is equal to the marginal cost of the damage caused by such activity" (Turner *et al* 1994) to modify their behaviors on waste management and waste over-generation minimization in a more cost-efficiency way (Wang & Lu 1997). Minimizing waste over-generation here includes both a slower waste generation rate and an increase in waste reuse, recycle and recovery to prevent waste from entering the final waste stream in the area. Hockett *et al* (1995) further claims that the size of the fee has a large potential in influencing the whole waste disposal since the higher tipping fees are; the lower levels of total waste will be.

Secondly, it can improve the integration of environmental objectives and policies from other sectors of our society, e.g. industrial, agricultural sectors, etc. With the incentive from the imposing of a waste disposal fee, households' decision to minimize waste over-generation can lead to a change in the conventional consumption patter and an alternative selection for simple packaging products, which through the market mechanism, can create and enforce another incentive accordingly for industries to change their traditional production pattern in the consideration of sustaining market competitiveness and finally attain the goal of minimizing waste over-generation in the old city of Ningbo.

Thirdly, a waste disposal fee can explicitly reflect the principle of "whoever creates the waste/environmental pollution[15] pays"; it can incorporate environmental damages caused by the waste over-generation into the full price of natural resources through market processes. A waste disposal fee can place a "price" on the negative impacts of the pollution and enforce the polluters (waste generators) to pay the costs.

Lastly but not the least, the implementation of waste disposal fee can raise the local revenues (Wang & Lu 1997). In a broader sense, the adoption of waste disposal fee can improve both economic and environmental performances in the old city of

[15] Environmental pollution is all the "cost" that polluters created on our society, e.g. public health

Ningbo. According to the investigation made by the State Statistic Bureau (2006), in the USA, waste disposal fee occupies 0.15% of the total household's income annually; in Switzerland, Germany and Austria, it accounts for around 0.3% of the overall household's income. The average annual income per capita in the old city of Ningbo was 19674 Yuan in the year 2006. Providing if Ningbo municipality charges 0.2% of the total households' income, then the "waste disposal fee" charged per person annually will be 39 Yuan. With a population of 1.7 million, the total "waste disposal fee" can be collected is 66.3 million. The waste disposal fee collected from individuals households can be allocated to invest in improving the current MSW management system and release local government's pressure on the severe shortage of capitals concerning MSW management. For example, the construction costs for a modern sanitary incineration plant with the capacity of treating 100 tons waste per day is above 40,000,000 Yuan. [16] This is far more than expensive for the old city of Ningbo to bear especially when the whole expense has to be completely borne locally. After making use of the collected revenue to improve the current unsustainable infrastructure and waste treatment facilities concerning MSW management in the area, the redundant money can also be used to meet other environmental needs, such as the promotion of environmental education and programmes.

In addition, Ningbo municipality has a strong intention to replace the old planned economy mode with a new market-oriented entrepreneur's management method on MSW management. With the waste disposal fee compensating the investment and the running costs of the MSW management system, private entrepreneurs and international corporations can be more attracted to invest in the establishment of a sustainable waste collection and disposal treatment system and consequently, solve the problem of the present MSB's low efficiency on waste handling. Table 6 summarized the dominant advantages of the adoption of a "waste disposal fee" in the old city of Ningbo.

Table.6 Dominant advantages of the adoption of a waste disposal fee in the old city of Ningbo.

	Advantages
Waste Disposal Fee	↓ Achieving environmental objective in a more cost-effective way with a comparatively cheaper administrative costs ↓ Implement Polluter-Pays-Principle & internalize full environmental costs ↓ Provide direct & indirect incentives to households and industries to minimize waste over-generation ↓ Generate revenues for improving MSW management facilities and provide financial support to other public environmental programmes ↓ Fast results & flexible

[16] Figure is from China garbage disposal website: http://www.garbagedisposal.cn/info.asp?id=110 accessed 6 April. 2007.

4.4. Limitations & potential risks of the adoption of a waste disposal fee

In spite of all the advantages that the introduction of a waste disposal fee can bring, it can still not fully guarantee or result in the expected objectives when its limitations are considered in terms of the local situation. A profound limitation concerning the "fee" solution is how to accurately value/monetize an appropriate price scale for all the social costs, including environmental damage, that waste over-generation can engender since unlike other commercial products in the market, environmental damages do not have a "correct" price. Not a single calculation can comprehensively cover all the social costs of the disposal of the waste, which has posed an awkward situation for the decision-making in the old city of Ningbo on the amount of waste disposal fee that shall be charged from the households. If the waste disposal fee is too low, households may not have adequate economic incentives to modify their waste management behavior and decisions; on the other hand, a too high waste disposal fee may create a huge possibility of an unexpected and unacceptable level of waste dumping elsewhere except the dustbins; or even the worst case scenario, no matter how much waste disposal fee is charged, there is no change in the quantities of waste generated, and the dumping of the waste will remain or even increase. Therefore, Fung (2000) recommended that a number of pilot projects be carried out in order to provide a better understanding of the possible household's reactions toward the adoption of the waste disposal fee.

What is more, another highlighted problem is in which way the waste disposal fee can be charged efficiently and effectively. A pragmatic collection method can be to charge the fee based on the amount (weight, or volume, e.g. bins or bags) of the total waste each household generated[17], which has been proved its feasibility with the experiences from Germany and varberg in Sweden, in which the waste reduction and increased reuse and recycling have been achieved (OECD 1998; Åerg *et al*. 1997). In the case of the old city of Ningbo, households are commonly dwelling in the multi-families buildings and blocks. Therefore, the normal practice in the area will be to divide the total waste disposal costs evenly among all households which may cause households' feelings of unfair treatments and therefore hinder the changes in household behavior in waste reduction. A weight- or volume-based waste disposal fee can, to a great extent, generate the economic incentives among households although high administrative costs can occur if separate bills are made and issued to each individual household (Fung 2000).

Moreover, to impose waste disposal fee among all households in the old city of Ningbo, negative distribution impacts, such as equity problem can take place. For low-income families, it is unfair to be imposed waste disposal fee if their livings are already poorly maintained. Therefore, this equity problem needs to be taken into account during the decision-making process. Conversely, some households can also

[17] Frequency is also an issue to be included.

be encouraged by the adoption of “waste disposal fee” and make use of the chance to “buy their rights to generate waste” if the reduction of waste costs more money and energy than to create. In order to largely avoid this situation, the basic social infrastructure and the public waste treatment facilities should be designed to be easy enough for the households to access in the old city of Ningbo.

The implementation of waste disposal fee may also increase a potential risk of collecting fees only for raising the consolidate revenues by the local government. Therefore, only the SEPA and its regional branch EPA have the rights to be in charge of collecting the waste disposal fee. However the collection and distribution of the charge revue should be under the surveillance of a joint board of representatives from local government and its related agencies, households, and the congress, etc. The adoption of waste disposal fee needs residents’ acceptance. The willingness of the households to pay the waste disposal fee is tightly related to the reliability of the MSW management service offered, therefore, high service efficiency among governmental agencies (section 6) is essential to ensure and attract the public interests and support. Additionally, a transparent and efficient use of the collected waste disposal fee with the purpose to enhance the MSW management system or to fulfill other related environmental objectives can increase public accountability on the waste disposal fee. Households need to be convinced that all the benefits will be returned although in a long-term perspective. What is worthy to note is that, as an economic instrument based on market mechanism, waste disposal fee is sensitive to the inflation. Therefore, it is important to re-valuate and adjust the charge every now and then, although this will add to the extra administrative costs. Table 7 presents the summation of the limitations and potential risks with the adoption of waste disposal fee in the old city of Ningbo.

Table.7 The summation of the limitations and potential risks with the adoption of waste disposal fee in the old city of Ningbo

	Limitations	***Risks***
Waste Disposal Fee	Impossible to accurately price all social costs	Too high/low charge
	The way to charge is problematic	Unfairness
	No consideration of the poor family	Equity concern
	Might encourage the case of “buying the right to generate waste”	More waste
	Only used for increasing consolidate revenue	Institutional power abuse
	Hard to attract a full public support	No acceptance
	Sensitivity to market change	The “fee” cannot reflect the real situation

4.5. Open discussion on the adoption of waste disposal fee

Fig3 shows that the policy response of the "fee" solution to resolve waste over-generation problem is not directed back to the driving force, but rather to the pressure stage. The "fee" solution is used only as a measure to achieve point-source waste reduction. Therefore, such response may fail to provide adequate results later. On the other hand, if the policy response is directed toward the driving force, will it be possible that a decoupling economic growth from waste over-generation may take place? Will the local and state government accept a decreasing or a much slower increasing economic growth? What will it bring to society?

5. THE CURRENT MSW MANAGEMENT STRUCTURE IN THE OLD CITY OF NINGBO

A general description of the current MSW management structure is presented in **fig 4** in order to provide readers with an understanding of how MSW management is carried out and who are involved in the overall MSW management system in the old city of Ningbo. It shows that the general MSW flow in the old city of Ningbo contains three main steps: MSW collection, transportation and treatment. Each community in the old city of Ningbo is required to have at least one Communal Collection Point (CCP). There are currently 15 Transfer Centers (TC) running in the old city of Ningbo, from where the MSW are compacted into pack trucks and sent to the Final Disposal Sites (FDS) (He, *et al* 2004).

Most households have the tradition to sell "valuable" waste, e.g. paper, cardboard, metal and plastic, to private waste collectors before delivering "valueless" waste, e.g. food residue, textile, etc. in the plastic bags to the nearby CCP. There is a maximum of 120 households sharing one CCP and a maximum distance of households reaching the CCPs is 50 meters. From there, DSBs and communities regularly collect the waste[18], but only DSBs transfers the waste to the TSs, and consequently, to the FDSs. Under this system, each household is required to pay to the communities approximately 5% hygiene maintaining fee of the total community fee monthly which can only cover a tiny portion of the cost for the waste managing[19] (SEPA 1998b).

[18] MSB and community collect the waste three times per week in winter and five times per week in summer time.

[19] The community uses the fee to hire workers to clean the stairs, windows and façades of the buildings and the outside areas of the building within the community.

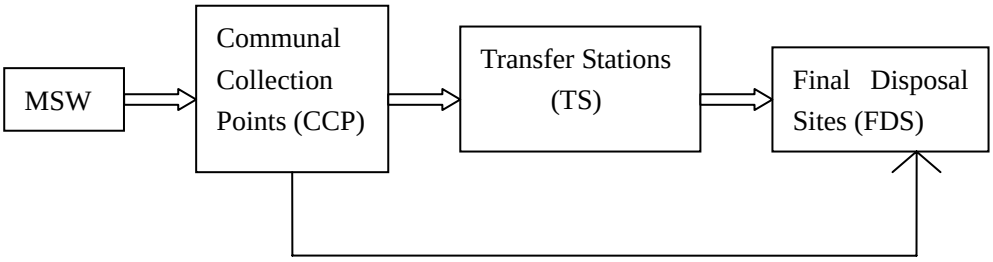

Fig.4 The general MSW flow from households in the old city of Ningbo

Private waste collectors collect or buy the "valuable" waste with a "lower collection costs and a higher return" (Fung 2000) from the households and sell them further to the waste recovery company or directly to industrial producers. A very small portion of the 'valuable waste" also goes to the MSB for the waste recycle, reuse or final incineration and landfilling. Waste like beverage glass bottles is within the take-back system. Once the products are consumed, the glass bottles can be returned to the retailers for the refund that the customers have pre-paid when they bought the beverage.[20] **Fig 5** illustrates this complex waste generation, collection and treatment process.

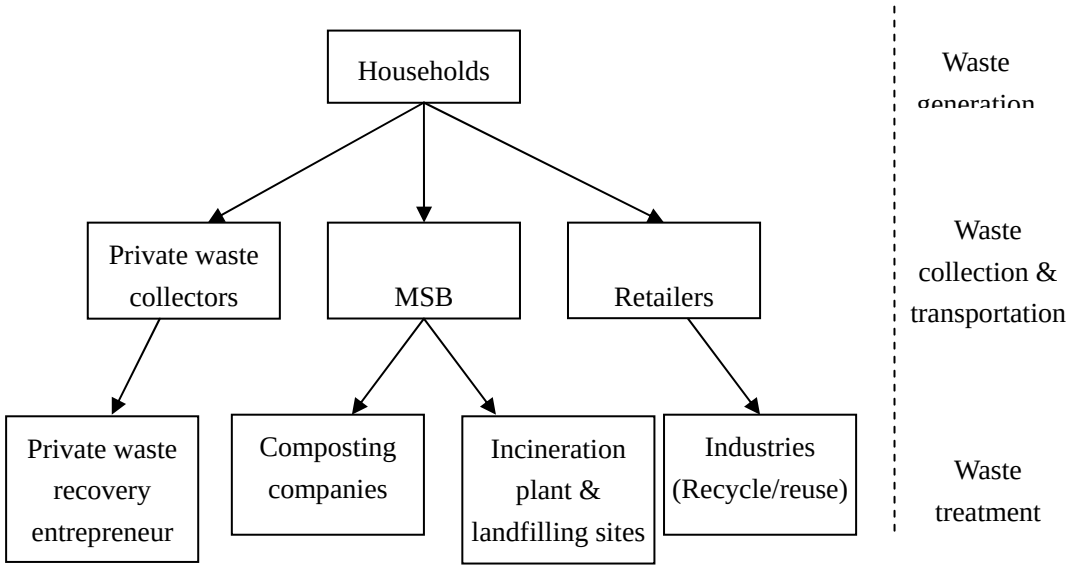

Fig.5 MSW generation, collection and treatment process in the old city of Ningbo

[20] Glass beverage, such as beer, has been replaced by the tin and plastic containers rapidly.

6. STAKEHOLDER ANALYSIS USING HÄGERSTRAND'S CONVENTIONAL NESTED SPATIAL DOMAIN SYSTEM & ITS APPLICATION IN IMPROVING STAKEHOLDERS PARTNERSHIP IN MSW MANAGEMENT

6.1. Hägerstrand's nested spatial domain system

Hägerstrand (2001) argues that a multi-level spatial domain system can be helpful to understand how macro- (large-scale decision-making) and micro-levels (actors) interacts with each other and how it works or fails to work. It is important to identify different actors' interaction within each sphere/level. *Functional specialization* indicates that each group of the actors at each level should be provided with "own set of rights, responsibilities and expertise" (Hägerstrand 2001). Thus, the actors can participate actively in its planning and implementation at different special domain. The domains are presented in a hierarchical order in which actors are divided into several levels and each level is held by the domains acting above it, e.g. the local government works below the provincial government; the provincial government works below the state government (Hägerstrand 2001). The spatial domain system can not only clearly illustrate how each upper level can influence the level below; it also allows the actors from the lowest level to influence the upper levels (e.g. in the form of trade union or non-governmental organizations (NGOs)) so to ensure the realization of a dynamic two-way flow of information between the upper and the lower (Hägerstrand 2001; Adger 2006).

6.2. Stakeholders involved in the MSW management system

The complex MSW management system in the old city of Ningbo concerns an extensive involvement of stakeholders. In general, all stakeholders can be divided into three categories: public, collective, and private. The public sector includes the state government, local municipality, Ningbo Municipal Sanitation Bureau (MSB) and its District Sanitation Bureau (DSBs) as well as some other related governmental institutions; collective sector refers to all local communities; private sector is developing rapidly recently, especially some small private entrepreneurs engaged into waste recovery, recycling and re-manufacturing[21].

6.2.1. Households

Households are the major MSW generation source in the area. As MSW service users, their current responsibilities of MSW management occupy a rather small part comparing with other stakeholders.

[21] At present, there are no strictly named state-owned wastes recovery, recycling and remanufacturing enterprises existing in the old city of Ningbo.
There were only four PET recovery enterprises in 1995 while at the end of 1996, the figure increased to 60 in the old city of Ningbo.

6.2.2. Communities

Together with MSB, communities are partly in charge of MSW collection within the communities. Community, both as the residence enjoying the waste service and a component in the overall waste management system, has a more closed relationship with the households and can thus, be more influential in encouraging households to reduce waste generation.

6.2.3. Local municipal government

Taylor (1999) points out that the ultimate responsibility of MSW management locates in the public sector. The local municipality has the responsibility of introducing and enforcing legal and regulatory frameworks associated with MSW management; at the meanwhile, ensuring all the frameworks covering all stakeholders to be developed, enforced and monitored (Fung 2000); guiding, carrying out as well as monitoring MSW service and management and providing supporting service, such as professional training programme, financial support, etc[22]; fulfilling the environmental health needs of the city and protect the citizens from anything endanger public health and sanitation needs, and finally create a common good (Taylor 1999). The commitment of Ningbo Municipality to the enhancing of MSW management productivity is the prerequisites for the development of a sustainable MSW management system.

6.2.4. Municipal Sanitation Bureau (MSB) & District Sanitation Bureau (DBS)

Ningbo is adopting a two level operation methods on MSW treatment — the Municipal Sanitation Bureau (MSB) and the District Sanitation Bureau (DSBs). The MSB is responsible for constituting urban sanitation development blueprint, monitoring, managing and executing the entire MSW management operation under the guidance of the local municipal government from a macroscopical perspective and the concrete MSW management task is undertaken through all the DSBs.

6.2.5. State Environmental Protection Agency (SEPA) & Regional Environmental Protection Agency (REPA)

The regional Environmental Protection Agency (EPA) of the State Environmental Protection Administration (SEPA)[23] has the responsibility to ensure the MSW management is safe, a minimized pollution arising from MSW treatment and the set standards and guidelines are being met (SEPA, 1995). Local municipality, MSB and DSBs have to send all environmental impacts assessments concerning MSW facilities and methods to SEPA and its regional branch for the approval. However, the influence of SEPA and its regional EPA in the old city of Ningbo is often small and thus is neglected from the whole MSW management.

[22] Subsidy distributed to MSB on MSW collection is 36 Yuan per ton; 42 Yuan per ton for MSW compact and 100 Yuan per ton for Fenglin incineration factory.

[23] The formerly known name of SEPA is National Environmental Protection Agency (NEPA).

6.2.6. Private waste collector

Private waste collectors are playing a vital role in carrying out source separation and providing the households with a more convenient channel to do the recyclables; however their existence has not yet acknowledged by the local government although no restrictions either. They are in many cases, the new immigrants from rural to urban. By trading waste, they gain a livelihood in the city.

6.2.7. Private waste recovery, recycling and remanufacturing entrepreneurs

The scale of private waste recovery, recycling and remanufacturing entrepreneurs is commonly small or medium. They are independent from the governmental authorities and assume sole responsibility for their own profits or losses. Motivated by adopting the lowest costs, they have a more flexible and efficient waste collection, recycle and remanufacturing channel. Their existence can reduce MSB and DSBs' waste management burden. Through the recovery of recyclable materials, less waste will enter the final waste stream and natural resources can be saved. It can also contribute to the reduction of the unemployment rate.

6.3. Analyzing the functioning efficiency between & among key stakeholders

The development discourse has a high demand for the prominent theme of stakeholder coordination (Jackson & Gariba 2002). To control and minimize the waste over-generation in the old city of Ningbo through the introduction of a waste disposal fee is a complex and large-scale process and concerns a wide range of relevant sectors, which highlights the fundamentality and complexities of efficiently co-operating all involved stakeholders at both national and local level. An effective stakeholder partnership appears to be particularly important with respect to resolving the problems of "who should collect the revenues" and "who should manage the assets" collected through the waste disposal fee (Jackson & Gariba 2002). A clear identification and clarification of the current status of stakeholder roles and responsibilities is helpful in seeking to construct the potential feasible strategies fitting the scenarios (**Fig6**). The past experience shows that there are two categories of demerits when describing the current low efficiency of stakeholder partnership concerning MSW management system in the area, namely, a lack of "vertical" balance between the state and the local level; and a lack of "horizontal" balance within the local stakeholders. Therefore, the key mechanism used to address the issue is to empower the local stakeholders under the decentralization of the jurisdiction, administrative power and responsibilities from the national level ("vertical") as well as to encourage a broad "horizontal" participation and coordination among the public and private sectors, households and communities at the local level which, in the context of the old city of Ningbo, appears to be more challenging.

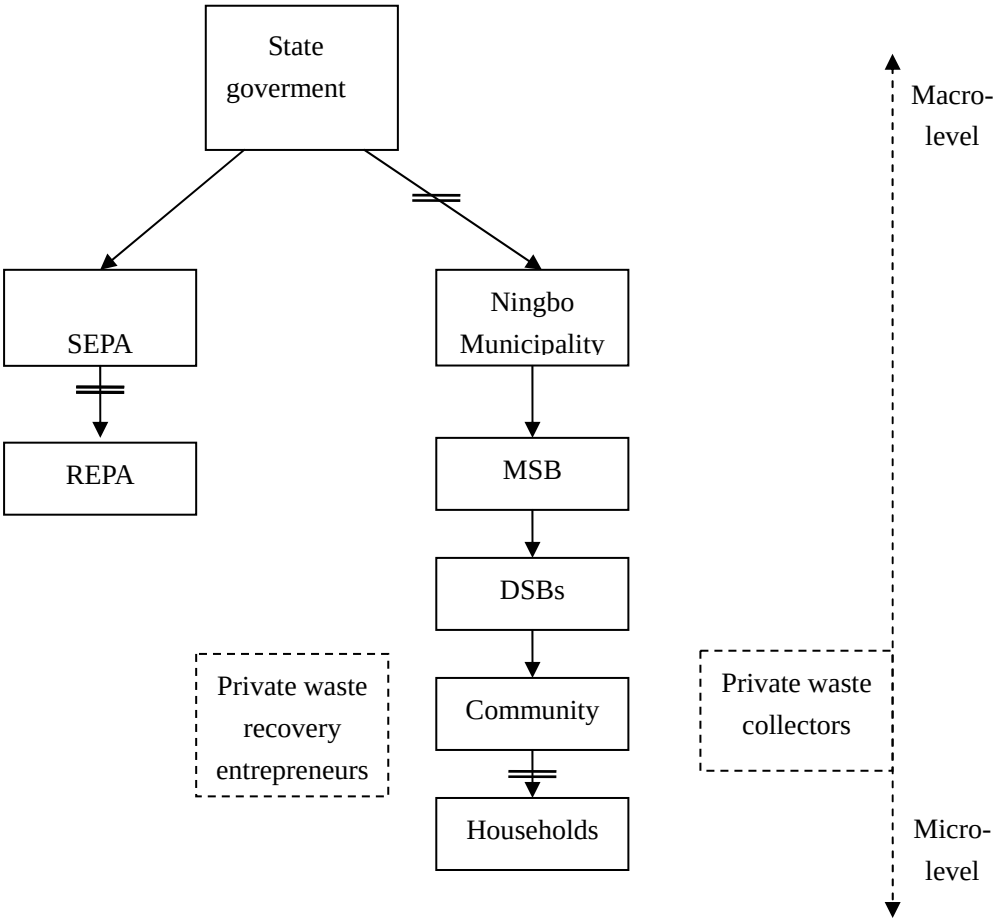

Fig.6 The current stakeholder partnership and the problems

═══ shows where problems exist

6.3.1. A lack of vertical balance between the state & the lower levels

Jackson and Gariba (2002) claim that for the public sector reform in developing countries, decentralization has become one of the most important elements for more than one decade. During the end of 1970s and the beginning of 1980s, Chen Yun firstly put forward the theory that the socialist planned economy should be complemented by the market regulation, which is named as socialist market economy later (Wu 2005). Under the long-term domination of planned economy, all decisions and resources concerning MSW operation and maintenance in the old city of Ningbo are highly centralized within the state government and SEPA, which deeply deteriorates the incentives of the stakeholders from the lower levels, e.g. MSB and its DSBs, regional EPA, etc., to carry out efficient and effective MSW management operations. The traditional policy response to the identified pressure from waste over-generation is usually a top-down legislative framework e.g. *Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste* (1995) (SEPA 1995). In top-down planning methods, state government

formulates plans at a national level and requires the compliance from the lower levels. In practice, the lower levels do not adhere strictly to the directness from the state government because of limited legal freedoms, different goal, perception and/or knowledge. With a highly centralized decisions at the upper level of the government, the top-down policy intends to create disparity between "those who formulate management goals" and those "who are requested to act" (Hägerstrand 2001). Particularly when China is now transmitting from planned economy to the market economy, the top-down policy is inflexible and can hardly provide sufficient incentives to stimulate local stakeholders' positive contribution to the overall MSW management system in the area and for households to minimize waste generation. The disparity even aggregates when the spatial scale of the problem grows since the perceptions between planners and local actors differ more as the spatial scale between the planner and the activities to be undertaken increase (Hägerstrand 2001; Grainger & Purvis 2004).

6.3.2. A lack of horizontal balance

In the view of the old city of Ningbo, a lack of horizontal balance implies firstly the ambiguous responsibilities classification among public stakeholders at the local level and their intense competition for the very limited local resources and mandate, which together undermine their cooperation and coordination; secondly, the exclusion of private sectors, e.g. private waste recovery entrepreneurs, and micro-level actors, e.g. households, from the overall stakeholder partnership.

Although the unity of management and the division of responsibility on MSW treatment is clearly stated in the *Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste* (1995), there is an inherent difficulty and fragmented policy across several governmental agencies with different policy mandates. The overlapping of the responsibilities and functions among different institutions in public sectors is a significant reason leading to a low stakeholder working efficiency and a distrust from the public toward MSW management system in the old city of Ningbo. For example, the regional EPA, which is at the same hierarchy in MSW management as MSB, however has the responsibility and right of overseeing and monitoring MSB and its DSBs' related MSW management operations. This seriously weakened MSB and DSBs' incentives of improving the current MSW management system and creates difficulties in enhancing cooperation between the two organizations when implementing new methods and mechanisms on waste minimization, e.g. "waste disposal fee". Moreover, the unclear responsibilities classification also creates the opportunity for institutions to escape the responsibility which they should bear and shift the responsibilities to others. In short, when different institutions are involved into one issue, the "cross-border" difficulties thus, arise.

Additionally, MSB in Ningbo emerged and developed from being an organization working only for streets-sweeping and waste transportation. With a higher city

sanitation demand, *The Solid Waste Pollution and Control Law (1995)* stated that under the current MSW management framework, MSB has the responsibility of monitoring and overseeing the entire MSW treatment system which means that MSB is supposed to monitor their own work. Thus, with a mixed two roles of both monitoring and being monitored, MSB does not have incentives to improve its working efficiency and to develop a sustainable MSW management system.

A sustainable MSW management system requires the development of an effective working partnership among various stakeholders concerning MSW management (Pfammatter & Schertenleib, 1996; Lardinois & Van de Klundert, 1997; Taylor, 1999). Incorporating the private stakeholders into the overall stakeholder partnership should be put in place for the ongoing collaboration. A limited and unsuccessful integration and cooperation between public and private sectors create MSW operational difficulties and undermine the efficiency of the MSW management in the area. Taylor also argues that in most cases, the limited resources of stakeholders are the general constrains for developing and obtaining a viable and efficient partnership between and among the various stakeholders. For instance, public sectors are inclined to have mistrusts or degrading views towards the private sectors and question the legitimacy of the members of the private sectors. (Taylor 1999). Therefore, the public MSW sectors commonly have limited interests to consider developing partnership with the private MSW sectors. There is a lack of willingness of public sectors to acknowledge the potential contribution that the private sectors may have in the issue of MSW management. Employees from public sectors are regarding themselves have a higher social status than those from private sectors because of a stable income and an authorized working position which largely reduces the enthusiasm of private sectors to get involved in the overall MSW management.

Conversely, private waste recovery entrepreneurs prefer more on creating quick profits instead of establishing a common insurance and other economical protection for the employees and the entrepreneurs themselves, which reduces public sectors' interests on accepting private sector as their potential partners; on the other hand, private wastes recovery entrepreneurs are usually reluctant to be in compliance with public stakeholders for the agreement and development on the same commercial requirements and the labor laws (Taylor 1999).

Hägerstrand (2001) stresses that when confronting large-scale, complex issues, such as waste over-generation, a holistic understanding of the interactions and connects between the macro level/larger-scale decision-making and micro-level actions/households action taking place on the landscape is essential. *The Solid Waste Pollution and Control Law (1995)* has a general aim to directly altering the environmental performance of the polluters (mainly industrial polluters) by regulating the process and product used. However households as the major MSW generators and waste service users, their responsibilities and roles in the overall MSW management have not been fully recognized under the current MSW management system. The low

community hygiene maintenance fee, on one side, cannot release the municipal government's financial pressure concerning MSW treatment operation; on the other hand, it reduces households' incentive to keep waste generation low and their potential contributions to the local MSW management.

6.4. Conceptualize the MSW management system with Hägerstrand's nested spatial domain system

In accordance with Hägerstrand's spatial domain system, decentralization and participation are the two most essential elements which can "bring decision making closer to the people and result in the provision of levels of services that the community can afford and maintain" (Ogu 2000). Hägerstrand emphasizes that the actions of social institutions should be partitioned into various special domains (**fig.7**) and the higher order domains (macro-scale), the state government should operate indirectly through setting goals, legal limits or creating incentives while the ultimate operations to decrease waste generation locates in the actor level (micro-scale), e.g. households (Hägerstrand 2001). It is significant to appropriately distribute responsibilities, authorities, jurisdiction, functions, rights and capacity power to the proper level of the institutions (Shubeler 1996). The decentralization of the administrative responsibilities and power can, on one hand, reduce the overload on the state government; on the other hand, achieve a cost-efficiency concerning MSW management since Ningbo municipality and all other local institutions have a better understanding of the local situation, thus can lead to a more flexible, efficient and responsive waste reduction control in terms of the local circumstances and potentials (Shubeler 1996).

The recommended option involves the national and local government jointly to set minimum standards concerning MSW management. Below the state government, SEPA and Ningbo municipality take joint responsibility to oversee MSB's operational performance, but from different perspectives since the municipality constitutes the local-focused regulations which are the complementary of the general legislation framework and goal set by the state government. Ningbo municipality thus, monitor the whole MSW management, especially from the political perspective while SEPA have full responsibility to support and monitor MSB's work from a technical perspective. MSB then focus on the overall waste management operations. On the third level, DSBs undertake the districts' detailed and concrete waste collection, transportation and disposal tasks. The regional EPA provides SEPA with relevant quantitative and qualitative information on waste generation, composition and other particular aspects as well as necessary innovation to improve the efficiency of the current MSW management based on the local specific situations. Through the interactions between SEPA and MSB, the new technical support will flow to DSBs dynamically. The regional EPA's work is sustained by the local environmental institutions and organizations as well as universities; below DSBs, communities have the full responsibility to raise households' awareness on the necessity of waste prevention and reduction and the general knowledge to manage the waste.

Households are situated in the last domain and their determination and activity (e.g. commitment to the waste reduction and a shift of the unsustainable consumption pattern which can further change the unsustainable industrial production pattern) can have a significant influence on the overall MSW generation in the old city of Ningbo.

To obtain an effective integration among various stakeholders, both private and public sectors need to show a common commitment and thus, establish a service-oriented collaboration for the improving of the MSW management (Taylor 1999). All stakeholders should be encouraged to get involved into the decision-making process concerning MSW management so as to contribute the ideas of alternatives to improve MSW management in the old city of Ningbo (Taylor 1999). Particularly, private sectors' contributions to the MSW management need to be officially recognized. The underlying purpose is to integrate and encompass the initiatives from all involved sectors into the local municipality's overall planning and goal on MSW management (Shubeler 1996). Private sectors should be encouraged to manage their business independently while regulation and controls from the local government are essential to guide and monitor the overall performance of the private sectors since in most cases, private waste recovery entrepreneurs have more interests in minimizing the waste recovery costs which may lead to "inadequate waste disposal practices", "bad working conditions" and "unsafe working facilities" (Shubeler 1996).

Fig.7 shows the recommended stakeholder partnership structure with the consideration of the theme of decentralization and participation in the old city of Ningbo for achieving a "vertical" and "horizontal" balance and an extensive corporation among all sectors based on Hägerstrand's spatial domain system.

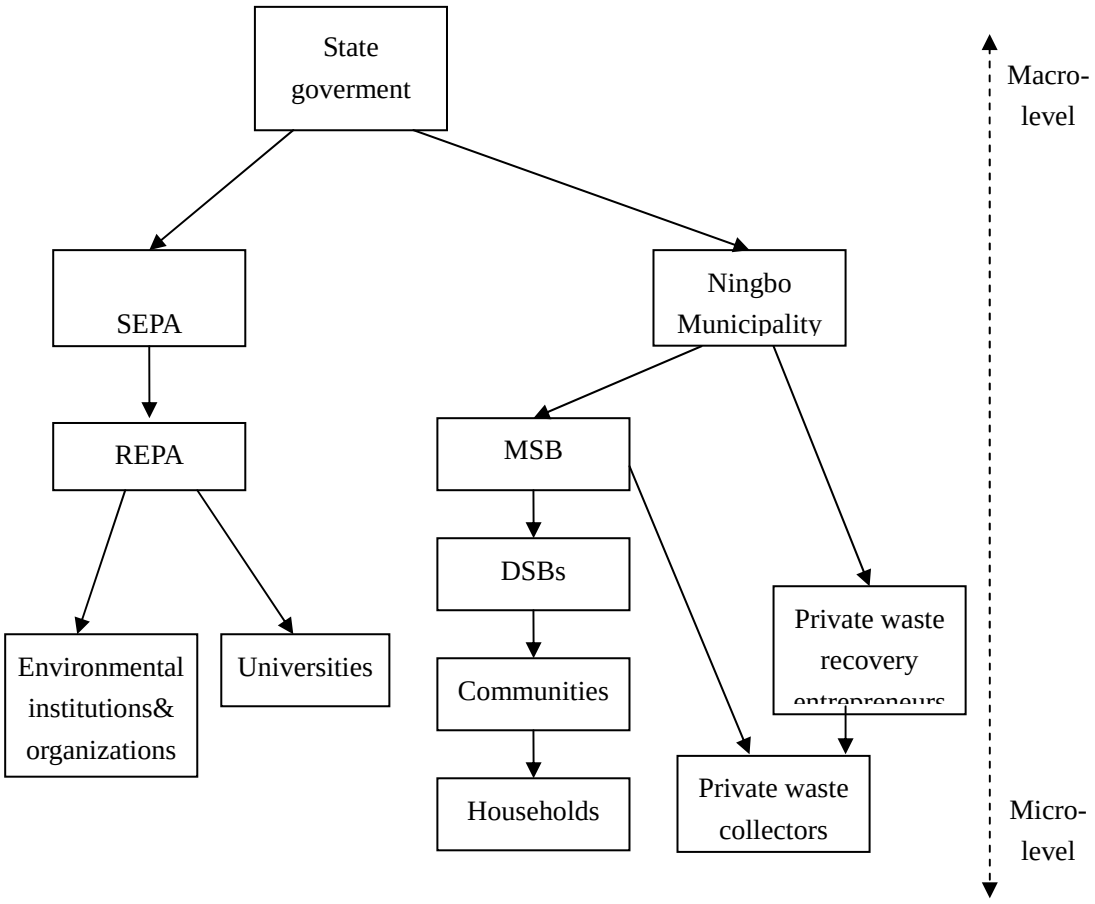

***Fig.7 Hägerstrand's nested spatial domain system applied on MSW management system in the old* city of Ningbo**

7. CONCLUSION

The government's high priority on the promotion of economic development since economic reform is a strong and underlying reason for the environmental deterioration in mainland China. The problem of rapid escalating MSW generation in mainland China has been arousing the concern both from the governmental level and the general public since it becomes a new environmental and financial constrain for achieving sustainable development in China.

This paper explored a case study in the old city of Ningbo in China. By using DPSIR model, the paper analyzed the causality behind MSW over-generation problem in the area. Economic growth was selected as one key driving force contributing to the MSW over-generation in the old city of Ningbo. In the paper, a hypothesis of the introduction of a waste disposal fee, developed from the interviews with the local households, was proposed for minimizing MSW over-generation in the area. The adoption of a waste disposal fee can result in a number of positive impacts, such as to mobilize households' enthusiasm for minimizing waste over-generation in a

cost-efficient way, to increase consolidate revenue and to reflect the Polluter-Pays-Principle, etc. All in all, the dominant advantage of imposing waste disposal fee is that it can force all stakeholders to take environmental concerns into account so as to minimize the negative impacts from their activities as much as possible;

However, limitations and potential risks in relation to the adoption of waste disposal fee may also arise. Therefore, the introduction of the waste disposal fee for the waste over-generation control should be considered in terms of local potentials and resources. The paper suggested that a weight- or volume- based waste disposal fee be pragmatic and can generate the economic incentives among households in the case of the old city of Ningbo. Practical experience and pilot projects are needed to decide on how much waste disposal fee should be charged. In order to avoid the situation of "buying the rights to generate waste", the basic social infrastructure and the public waste treatment facilities should be designed to be easy enough for the households to access in the area.

The residents' acceptance of the waste disposal fee depends significantly on the reliability of the MSW management service provided. Therefore, high service efficiency among stakeholders is essential to ensure and attract a wide public support. The paper thus, also analyzed the functioning efficiency from various stakeholders within local MSW management system and concluded that ineffective stakeholder partnership is a huge barrier for efficiently and effectively controlling and minimizing the quantity of waste that over-generated and further, a sustainable MSW management system in the area. With Hägerstrand's spatial domain system, the paper re-classified the responsibilities, authorities, and jurisdiction among all involved stakeholders for establishing a concrete institutional base for the implementation of the waste disposal fee through the promotion of the prominent theme of decentralization and stakeholder participation. It is also suggested in the paper that the state government should operate indirectly through setting goals, legal limits or creating incentives while the ultimate operations to decrease MSW generation should locate in the actor level.

REFERENCES

Adger NW, Brown K, Tompkins EL, (2006), *Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World*, Ecol. & Soc., 10 (2), assessed 6 May 2007.
http://www.ecologyandsociety.org/viewissue.php?id=66#Guest_Editorial

Beukering PV, Li YJ, Zhao YM, Zhou X, (1997), *Trends and Issues in the Plastic Cycle in China with Special Emphasis on Trade and Recycling*, CREED Working Paper Series No 16. [online]
http://prem-online.org/archive/17/doc/creed16e.pdf

Chang N, Pan Y, Huang S, (1993), *Time series forecasting of solid waste generation*, Journal of Resource Management and Technology 21: pp 1–9.

Chung SS, Poon CS, (2001), *Characterisation of municipal solid waste and its recyclable contents of Guangzhou*, Waste Management & Research 19: 473-485.

Cointreau-Levine S, (1994), *Private Sector Participation in Municipal Solid Waste Services in Developing Countries, I, the Formal Sector, Discussion Paper 13,* under the auspices of the United Nations Development Programme, United Nations Center for Human Settlements (Habitat), and World Bank-sponsored Urban Management Programme. Washington, D.C., USA: World Bank.

Douglass M, Lee YSF, (1996), *Urban priorities for action.* In: World Resources 1996-97. A joint publication by the World Resources Institute, The United Nations Environmental Programme, The United Nations Development Programme, and The World Bank. New York, NY, USA: Oxford University Press, pp 103-124.

European Environmental Agency (EEA), (1999), *Environmental indicators, Typology and overview*. European Environmental Agency: Copenhagen. P. [online]
http://reports.eea.europa.eu/TEC25/en/tech_25_text.pdf accessed 21 May, 2007

Environmental Protection Bureau of China, (1995), *Agenda for Environmental Protection in the 21st Century*. Beijing, China: China Environmental Science Press. [In Chinese]

European Union, (1999), *EU Focus on Waste Management: European Commission Directorate-General Environment, Nuclear Safety and Civil Protection*, European Communities. [online]
http://europa.eu.int/comm/environmentlwaste/facts_en.htm (PDF format) 10

Fullerton D, Mohr RD, (2003), *Suggested Subsidies are Sub-optimal Unless*

Combined with an Output Tax, Contributions to Economic Analysis & Policy, Vol. 2, Issue 1, Article 1.

Fung SWF, (2000), *Handling the Municipal Solid Waste in China --a Case study of policies for 'White pollution' in Beijing*, IIIEE Communications 2000:8.

Grainger A, Purvis M, (2004), *Exploring Sustainable Development, Geographical Perspectives*, ed. London: Sterling.

He DS, Zhang JM, Shi LR, (2004), *A Preliminary Exploration for the Current Situation and Countermeasure of Domestic Waste Treatment in Ningbo City*, Environmental Sanitation Engineering 12: 1. [In Chinese]

Hockett D, Douglas JL, Pilgrim K, (1995), *Determinants of Per Capita Municipal Solid Waste Generation in the Southeast United States*, Journal of Environmental Management 45: pp 205-217.

Hägerstrand T, (2001), *A Look at the Political Geography of Environmental Management*. Sustainable Landscapes and Lifeways: Scale and Appropriateness, ed. A Buttimer, Cork University Press: Ireland, pp35-38.

Klijn JA, ed (2004), *Driving Forces Behind Landscape Transformation in Europe, From a Conceptual Approach to Policy Options, The New Dimensions of the European Landscape*, ed. RHG Jongman. Vol.4. Springer: Dordrecht, pp 201-219.

Jackson ET, Gariba S, (2002), *Complexity in Local Stakeholder Coordination: Decentralization and Community Water Management in Northern Ghana*, Public Administration & Development: 22. pp. 135-140.

Jenkins RR, (1993), *The Economics of Solid Waste Reduction. The Impact of Users Fees*, Brookfield, VT: Edward Elgar Publishing Limited.

Lardinois I, Van de Klunder A, (1997), *Integreated sustainable waste management*, In: UWEP Programme Policy Meeting Reader, 13-15 May. Gouda, the Netherlands WASTE Urban Waste Expertise Programme.

Lin YC, (2002), *The Technical Standards and rules Applied on Municipal Solid Wastes Management*, Beijing, China: Guangming Daily Newspaper Press. [In Chinese]

Naturvårdsverket, (2005), *Economic Instruments for the Environment*, Stockholm: Naturvårdsverket.
http://www.naturvardsverket.se/Documents/publikationer/620-8221-3.pdf accessed 7 May. 2007.

Ningbo Municipality Bureau, (2003), *The Full-scale Layout of Municipal Development in Ningbo*, Beijing, China: China State Press. [In Chinese]

Ningbo Statistics Bureau, (2003), *Ningbo Statistics Almanac*, Beijing, China: China Statistics Press. [In Chinese]

Ningbo: *Statistics of National Economy and Social Development of Ningbo*, http://www.nhstats.gov.cn/news_view.asp?newsid=286, accessed 20 March, 2007.

Ningbo, http://www.answers.com/topic/ningbo, accessed 15 March, 2007.

Ogu V L, (2000), *Stakeholders' Partnership Approach to Infrastructure Provision and Management in Developing World Cities: Lessons from the Sustainable Ibadan Project*, Habitat International 24: pp 517-533.

Organization for Economic Co-operation and Development (OECD), (1975), *The Polluter Pays Principle*, Paris, France.

----, (1994), *Managing the Environment: The Role of Economic Instrument,* Paris, France.

----, (1998), *Waste Minimisation Profiles of OECD Member Countries,* Paris, France.

----, (2005), *OECD glossary of statistical terms,* http://stats.oecd.org/glossary/detail.asp?ID=6408 accessed 6 May, 2007.

Parfitt J, (2002), *Analysis of Household Waste Composition and Factors Driving Waste Increases,* WRAP.
http://www.cabinetoffice.gov.uk/strategy/work_areas/waste/background.asp
accessed 7 May, 2007.

Pfammatter R, Schertenleib R, (1996), *Non-governmental Refuse Collection in low-income Urban Areas: Lessons Learned from Selected Schemes in Asia, Africa, and Latin America.* SANDEC Report 1/96. Dubendorf, Switzerland: Department of Water and Sanitation in Developing Countries, Swiss Federal Institute for Environmental Science and Technology.

Rathje W, Murphy C, (1992), *Rubbish: The Archaeology of Garbage*. NY: Harper Collins.

Shubeler P, (1996), *Conceptual Framework for Municipal Solid Waste Management in Low-Income countries, Urban Management Programme Working Paper 9.* UNDP/UNCHS(Habitat)/World Bank/SDC Collaborative Programme on Municipal Solid Waste management in Low-Income Countries. St. Gallen, Switzerland: Swiss Centre for Development Corporation in Technology and Management.

Serageldin I, Barrett R, Martin-Brown J, (eds), (1995), *The business of sustainable cities: public-private partnerships for creative technical and institutional solutions.* Environmentally Sustainable Development Proceedings Series No. 7, Washington, DC, USA: World Bank.

State Environmental Protection Administration (SEPA), (1995), *Environmental pollution control and measures in China*, Publication of Environmental Science in China, Beijing, China. [In Chinese]

----, (1998a), *'The Studies of the Existing Situation and Strategies for Management of Household Waste in Urban Areas' in The Strategies for Controlling Environmental Pollution in China*, Publication of Environmental Science in China, Beijing, China. [In Chinese]

----, (1998b), *'The Studies of the Existing Situation and Prevention Strategies for White Pollution' in The Strategies for Controlling Environmental Pollution in China*, Publication of Environmental Science in China, Beijing, China. [In Chinese]

State Environmental Protection Administration (SEPA), (1995), *Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste,* http://english.sepa.gov.cn/zffg/fl/199510/t19951030_49701.htm, accessed 2 April, 2007.

Taylor DC, (1999), *Mobilizing resources to collect municipal solid waste: illustrative East Asian case studies,* Waste Management Research 17: 263-274.

Theodore P, (1993), *Economic Instruments for Environmental Management in Developing Countries* in OECD Document (1993a), Paris, France.

Turner RK, Rearce D, Bateman I, (1994), *Environmental Economics: An Elementary Introduction.* Harvester Wheatsheaf, London: England.

UNEP: United Nations Environment Programme/GRID-Arendal: Maps and Graphics. DPSIR Framework for State of Environment Reporting, 2002, [online] http://www.unep.org/vitalwater/12.htm#13 accessed 16 May, 2007.

UNCED, (1992a), *Declaration of the United Nations* Conference on Environment and Development, Riode Janeiro, Brazil.

UNCED, (1992b), *Agenda 21,* Riode Janeiro, Brazil.

US EPA, (1995), *Decision Maker's Guide to Solid Waste Management,* Volume II, (EPA 530-R-95-023), Washington DC, [online] http://www.epa.gov/epaoswer/non-hw/muncpl/dmg2/preface.pdf

Wang JN, Lu XY, (1997), *Economic Policies for Environmental Protection in China: Practice and Perspectives in OECD Document (1997b), Applying Market-Based Instruments to Environmental Policies in China and OECD Countries,* Paris, France.

Wu YF, (2005), *The Theoretical Trajectory of Development from Socialist Commodity Production to Socialist Market Economy,* Contemporary China History Studies 5: 25.

Yin RK, (2003), *Case Study Research – Design and Methods*, Thousand Oaks, California: Sage.

Zhou Q, Yu J, (1997), *Plant growth and its stabilization effects in Landfills,* Environmental Pollution and Control Supplement pp. 2-4. [In Chinese]

Zhu K, (2005), *Improving MSW treatment system and Protect the Living Environment,* http://www.garbagedisposal.cn/info.asp?id=111, accessed 22 March, 2007.

Åberg H, et al., (1997), *The Household and the Environment: Purchase and Waste Behaviour in Households and the Introduction of Weight-Based Billing – Final Report,* AFR-report 179, Swedish Environmental Protection Agency, Stockholm, Sweden.

APPENDIX:

Graph.1 Ningbo & China

(Source: http://www.kaesung.co.kr/img/map_china.gif)

Graph.2 The old city of Ningbo & other districts

(Source: yahoo image)