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Municipal Solid Waste Management Practices in Urumqi

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Table of Contents

1 Introduction

1.1 Background of Research

“Half of the world’s current population of around 6.4 billion people lives in urban centres.” (Satterthwaite, 2007 p. 1) The concentrate of large population in urban centres conducts various negative environmental impacts including issues of hazardous waste management or environment destruction because of excessive consumption of natural resources, which major challenges are facing a lot of countries and inhabitants who are living there. Consequently, it is necessary for cities to implement adept processes such as urban planning and management to reduce the risks towards inhabitants as well as municipal infrastructure from climate change related impacts, since “Urban centres and the infrastructure they concentrate … are often capable of considerable adaptation in order to reduce risks from the direct and indirect impacts of climate change”, (Satterthwaite, et al., 2009 p. 4) which will be a key part of the government’s strategy for regional sustainability.

Neither the causation nor the impacts of climate change can be seen in isolation. They have human causes, human effects, results of human mismanagement and leading to further degradation of the environment. Phenomenon in terms of environmental degradation or protection cause more and more global interests and concerns. Consequently, it requires increasing international cooperation to address environmental remediation programs, or to promote information exchange and cooperative researches on issues related to environmental pollution. More important, with a special emphasis on ensuring that lessons learned in the development process by industrialized countries are passed on to countries in their economic transition. These cooperative programs will take missions that enable the local urban authorities as well as civil society groups in terms of their knowledge and awareness to reduce vulnerability of urban inhabitants and infrastructure to many direct and indirect negative impacts of climate change, helping municipal government as well as local inhabitants to consider in a way, with ecological perspectives, what kind of holistic

measurements might be needed that can underpin long-term planning for further urban development.

As the largest administrative region in China, Xinjiang owns one of the world's largest sandy waste "Taklimakan Desert" as well as one of the biggest cities in western China, Urumqi, locating only 13 hundreds kilometers away from the edge of Taklimakan. The environmental vulnerability in this region has been proved by numerous cases. One of the most famous event is often cited as an example, — "Lop Nur", — once was the second largest inland lake China finally disappeared since only few decades. The hard environmental condition and increasing global climate change has been enlarged the vulnerability in this region much more than in most of other regions in the world. Environmental problems, such as extreme weather events, air pollution, biodiversity loss or desertification etc., have never stopped to bothering the people who are living on this land. The development of local economic provides more opportunities to conquer the environmental disadvantages, but unfortunately, the relationship between human beings and environment tends getting worse due to the sequent negative effects caused by economic development as well. Implementation of ecological development strategies in further urban planning and construction, which focuses on the interaction between the physical environment and social organization and behavior, could probably help Urumqi and Urumqier avoiding to become another abandoned city, like many other famous disappeared cities once flourished on the ancient "silk road", who lost the battles against negative environmental impacts, leaves only ruins remains today.

1.2 Project RECAST

Project RECAST Urumqi is the abbreviation for "Meeting the Resource Efficiency Challenge in a ClimAte SensiTive Dryland Megacity Environment: Urumqi as a Model City for Central Asia"[1]. It is a bilateral cooperative environment research project within the framework of the program "Research for Sustainable Development of the megacities of Tomorrow", sponsored and supported by Federal Ministry of

[1] See official homepage: http://www.urumqi-drylandmegacity.uni-hd.de/

Education and Research". [2] According to the report of IIED, in every four "million cities" (with more than one million inhabitants) in the world there is one from China. (Satterthwaite, 2007 p. 10) As one of the megacity from China which is also in midst of economic and social transition, Urumqi is an appropriate research objective, the approaches on which will also helpful, as a representative model, to future urban development in other low-income or middle-income counties.

RECATS aims at approaching development strategies and tools for the sustainable development, by keeping not only such a long-term policy on the political agenda, but also generating interest and action from private sectors and individual people on the ground. By adopting assembling, presenting and contesting as key tasks of each environmental problem with special focus on three fundamental environmental behaviors, i.e. materials efficiency, water saving and energy conservation, the international, interdisciplinary project will draw up the further guideline in terms of interaction between the physical environment and social organization as well as human behavior in Urumqi region. Success depends upon international cooperation, including sharing not only lessons learned but technological innovations and the financial resources necessary to implement them. Furthermore, a close cooperation with local authorities and institutions will also enable the local government go much more far on issue building and agenda setting, finding ways to allow economic development without further contaminating our development.

This thesis tries to contribute approach on households' waste material flow in Urumqi. It will demonstrate the existing condition of municipal solid waste management in Urumqi, by providing reliable statistic data, presenting legislative framework and applied technologies from waste collection to discharge and treatment. The research currently on which is nothing more than an uncharted map. This approach is going to support the further comprehensive implementation of strategies and tools in the region.

[2] See official homepage: http://www.emerging-megacities.org/seiten-kopf/startseite/startseite-en.aspx?AspxAutoDetectCookieSupport=1

1.3 Urban Problems in Urumqi

Catton and Dunlap embodied three general functions, living space, supply depot and waste repository in their model to describe environmental destruction, and in which way, serves environment human beings. (Dunlap, 1993 p. 717) We used to think that there is nothing to worry about of using nature resources as they are the gifts of the earth. However, we realized the truth that as a consequence of industrialization and urbanization and subsequent massive production and consumption, the "overuse of nature resources results in shortages or scarcities". (Hannigan, 1995 p. 17) Catton and Dunlap used the figure to present the environmental condition that was at the beginning and on end of twenty century in USA and other industrial countries. However, history repeats itself. Same problems took place also in China and Urumqi, in their developing process, but in a very short time period.

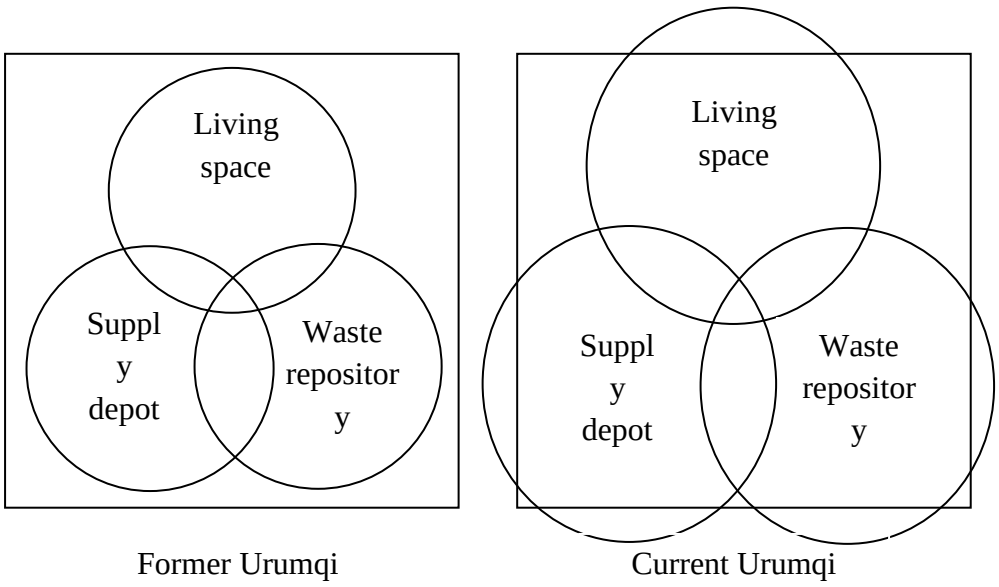


Figure 1. Competing functions of the environment
Source: (Dunlap, 1993 p. 717), reserved to present Urumqi

In recent 20 years, Urumqi was a rapid developing city with dramatic economic and social transition. Municipal population has been expanded over 2/3 in past 10 years; gross domestic product (GDP) in 2007 was three times bigger than the level in 1995, while municipal solid waste (MSW) amount is three times now than the amount at

the beginning of 1990. As the result of economic development, the living conditions of the people have been improved accordingly. However, much of these physical expansion and economic growth took place outside of adequate long-term plans as well as required rules and regulations, which brought series of social and environmental impacts and problems subsequent industrialization and urbanization process which sharpened the conflict, among the three competing functions of the environment considerably. Urumqi is a typical city that is contributing, while also strongly sufferings of environmental hazards as well as other impacts sequent climate change. Without an adept solutions to balance the human ambition on economic growth and the functional environment preservation, a further sustainable local development is by no means possible but will also be, and already is, a noticeable threaten to inhabitants in Urumqi. We are not allowed to turn a blind eye to environment destruction and the bad environmental condition there, such as harmful pollutants in the air, and swage outflow into urban water ways or garbage discharge in landfill with only or without even primary treatment, which would not be acceptable in other lands.

1.4 Structure of the Thesis

This thesis engages in providing comprehensive understanding of MSWM in Urumqi as a linear process from generation to disposal. It consists of the legislative framework, quantitative conditions, material flows and environmental behaviors etc. with a respect of national and regional peculiarities in economic and social activities. I adopt explicitly economical and environmental perspective in order to acquaint local environmental vulnerabilities, as well as environmental problems and risks that caused by increasing MSW, so that to find the balance between economic development and environmental protection.

The thesis can be generally divided into following parts:

Chapter 2 demonstrates the social and economic condition of the region with environmental concerns. Several serve environmental problems such air pollution and waste hazards will be introduced.

Chapter 3 ranges over the topic of environmental regulatory framework both in China and in Urumqi. It will not prescribe (or describe) specific material ordinance, but will focus on contextually-grounded necessary introductions in order to highlight the fundamental infrastructures that environment related activities are based on. It includes the codification booms of environmental protection in recent years and MSW related policies, laws and regulations. The institutional structure will also be briefly introduced.

Chapter 4 and 5 demonstrate the physical and technical status quo of MSW and further practices relating MSWM in Urumqi. Chapter 4 will introduce the quantitative development of MSW in history, provide analyze of MSW composition. The cost calculation of MSWM services and the present pricing and charging system will also be introduced in this chapter. The material lows for MSW in Urumqi will be described in Chapter 5, through the introduction of applied technologies and management processes in MSWM. In Addition, as an important role in MSW collecting and recycling, a study of informal factors will be formulated in this chapter as well.

A questionnaire to survey individual attitudes and behaviors of households toward environmental issues has been adopted in 2008, within the “new” district of Urumqi, Midong. The survey was conducted with households’ members through face-to-face interviews with designed questionnaires. The main environmental impacts and problems that arise behind economic development in Midong have been identified through the survey. An analytical discussion of statistical outcomes as well as further inhabitant’s environmental behaviors will also be provided. Chapter 6 introduces these topics.

Chapter 7 will conclude the thesis by summarizing primary topics and conducted results and presenting the outlook and recommendations for the future.

2 An overview of City Urumqi with Environmental Considerations

2.1 Overview of the City Urumqi

As the administrative centre of the largest province in China — Xinjiang Uyghur Autonomous Region, which possesses one-sixth of China's landmass (Becquelin, 2000 p. 65) — Urumqi has influences in politics, economic, culture, science and technology in general contributes to its position in Xinjiang. It is one of the largest cities and major industrial and commercial centre in western China.

2.1.1 "Urumqi" in History

Xinjiang is home to some of oldest civilization in the world. First appear of the word "Urumqi" could be traced back to the year 925 A.D, in a book called "Shihexiji" (The book was written in Hetian Saka, which was founded in "Dunhuang Scrolls"). The original meaning of this word is no longer cognizable; however, in Mongolian language "Urumqi" means the "beautiful pastureland", which revealed that in the ancient time it was ever an area with plenty of water and lush grass.

The first time the city was established in history, — or we say that it was surrounded by walls — was until 1755, the former Chinese governor "Qing", built a frontier fortification as well as some basic city sectors, and the city was for first time named as "Urumqi" officially. After 8 years, in 1763 the city's name has been changed to "Dihua" and became the military and administrative centre of northeastern Xinjiang, connecting communications to the north of the Tianshan Mountains and the settlements of Hami and Turbans. (Dillon, 2004 pp. 17-18) Dihua was abandoned on 1st February 1954, when the Xinjiang Uyghur Autonomous Region established, while the city was renamed Urumqi again.

2.1.2 The Administrative Region and Population of Urumqi City

The total administrative urban area of Urumqi covers around 14,216.30 square kilometers, in which the municipal construction land area covers 235.88 square kilometers. The city is home of 2,018,443 people and 632,525 households - about 3.19 persons per household on average. Non-agricultural population accounts about for more than 78% of the total population. The human population density is 185.17 inhabitants / sq km. (Annual Report Urumqi , 2007 p. 25)

	Square meter	Population ②
Urumqi City ①	14216.30	2,018,443
Tianshan District	171	487544
Saybagh District	422.47	444254
Xinshi District	142.52	376600
Shuimogou District	91.56	163945
Toutunhe District	275.59	124339
Dabancheng District	5187.58	41770
Midong District ③	3407.42	29.6×10^3
Urumqi County	4332	82349

Table 1, Population and Area of Urumqi and its eight subdivisions
Source: "The Administrative Division of the People's Republic of China" (2006), http://www.xzqh.org/quhua/65xj/01wulumuqi.htm#qh
①: Exclude Midong
②: Population as of the end 2003, exclude Midong
③: Data of Midong: 2008

Urumqi consists of eight subdivisions includes seven districts as well as one county, i.e. “Tianshan District”, “Saybagh District”, “Xinshi District”, “Shuimogou District”, “Toutunhe District”, “Dabancheng District”, “Midong District” and “Urumqi County”. (See Table 1) In addition, there are two state-level development zones, “Urumqi High and New Technology Industrial Development Zone”, and “Urumqi Economic and Technological Development Zone Industrial Park; six national reclaimation farms, “Wuyi Farm”, “Sanping Farm”, “Toutunhe Farm”, “Xishan Farm”, “104 Regimental Farm”, “Poultry Farm”.

2.1.3 The Ethnic Composition of Population

Xinjiang and Urumqi have diverse range of people due to incessant immigration in their long history. Xinjiang was in ancient time known by Chinese as the “Xiyu” which means the “Western Regions”. It was and also is the junction in the middle of East-West economic and cultural exchanges, where a multi-ethnic and multi-cultural feature emerged. The first time that a large group of Chinese-Han people immigrated into this region was in eighteenth century while the name Xinjiang was given in this period – which means “New Frontier”, was probably used by former Chinese dynastic Qing for the first time in 1768. Since then, Chinese-Han people, as well as their language and their culture, followed their armies begun to move westwards to this new frontier territories on a large scale. (Dillon, 2004 p. 18) This immigration had never stopped even in the new period of “Xinjiang Uygur Autonomous Region”, which was founded on 1st October, 1955.

Therefore, the current ethnic composition of population in Xinjiang is extraordinarily complex. The major ethnic group in Xinjiang is the Uyghur, the people after whom the autonomous region is named. The Chinese-Han population also accounts for the majority among the total population in the region. While population of the other ethnic minorities are in the minority, which includes for example, the Kazakhs, Hui, Kyrgyz, Uzbeks, Tajiks, Mongolian etc., about 47 different ethnic groups (including Chinese-Han and Uygur). Xinjiang has a total population of 20.96 million; the population birth rate refers to 16.79 ‰. Among all ethnic groups, there are 8.98 million Uyghur, comprises 45.73% of the total population; Chinese-Han are about 7.8 million, makes up 39.75% of the total population; Kazakhs are 1.38 million,

accounts for 7.04% of the total population in Xinjiang. (Annual Report Xinjiang, 2007 S. 75 & 88) However, the ethnic composition and its proportion in Urumqi is not as exactly same as in Xinjiang. Chinese-Han is the largest ethnic component of population in Urumqi. They account for 74.7% of total population in Urumqi. Except for Chinese-Han, the other twelve native ethnic groups are Uighur, Hui, Kazak, Manchu, Xibe, Mongolian, Kirgiz, Tajik, Tatar, Ozbek, Russian, Daur. (Annual Report Urumqi , 2007 p. 26)

There are a lot of factors relating to generation of Municipal Solid Waste (MSW), such as the growth of population or the customs. The population scale is usually considered being correlated positively to the amount of the MSW. Meanwhile, the customs has been thought as one of the most important parameters to effect the composition of the MSW as well as the other physical and chemical characteristics of the MSW, such as density, moisture content, chemical compositions etc. By choosing the right treatment of MSW are those factors determinate. In Urumqi, this is obviously a considerable factor as there are so many different ethnic groups living together but in different ways. Two largest groups Chinese-Han and Uygur are most representative among all these groups.

2.1.4 Economic Growth and Resources Reserve

The traditional economy in Xinjiang was dominated by stockbreeding and nomadic pastoralism. Today the most of nomadic groups are permanently settled down and do not travel around anymore. Oasis agriculture still remains important. Prior to 1980, most of the cultivated land in the Tarim Basin region was used for grain production. However, by the 1990s, the region experienced a boom in cotton production. Most of the cultivated land in the Tarim River Basin became to engage in cotton production. As a result, a large volume of unused land was converted into cotton fields, because of economic incentives and water scarcity. (Jiang, et al., 2005 pp. 478-480) Today, Xinjiang is one of the China’s biggest cotton-production hubs gained a global reputation of producing high quality cotton, especially long-fiber cotton. However, water scarcity is still the serious restriction of agriculture development in Xinjiang, causing various kinds of land degradation, such as desertification or soil salinity.

Xinjiang has plenty of natural resource reserve and is a major base of strategic energy region in China. Explore and export of petroleum oil, coal, natural gas, and non-ferrous metals has been making huge economic benefit for the region and the country as well. However, on the other hand, enormous reserve of nature resources cause not only extremely under-valuated price on them, but also create a biased impression that there are inexhaustible resources, leading to the unrestrained use of natural resources. In the praxis, for example, coal is commonly used for power generation for heating. It is hard to be substituted by other cleaner type of energies, because the coal is unbelievable cheap in China. Although as one of the largest cities in China with the severe air pollution — which is most likely caused by over-consumption of coal-fired electrical power plant. However, from an economic point of view, it is hard to convince people or producers to consume other cleaner but relative expensive energy.

	Coal billion tonnes	**Oil** million tonnes	**Natural Gas** billion m^3
Xinjiang	12.73	418.83	659.82
Proportional in National Total	3.8%	15.2%	22.0%
Rank among the Provence in China	5	2	2

Table 2. Reserve Base of Coal, Oil, and Natural Gas of Xinjiang, 2006
Source: China Energy Databook v. 7.0, October 2008

The recent dramatic economic growth and modernization of Xinjiang occurred in synchronism with the implementation of national political strategy “reform and opening” in overall China since 1978. During 1990s, a highly visible and startling

transformation in various parts of Xinjiang took place, as a result of massive investment in the infrastructure of the region as well as the benefits of foreign trade with the newly independent states of the former Soviet Union. However, the quick development was occurred apparently in Urumqi and other major cities more than in the other underdeveloped rural region in Xinjiang.

As the major economic and industrial centre of Xinjiang, Urumqi has also made a fast development since 1990. The shape curve in the following graph, which represents the GDP growth in Urumqi between 1996 and 2007, is showing that the GDP level in 2007 is equivalent about four times to the level in 1996, reached 782 billion Yuan (not include Midong), which increased by an average of 15.2 percent, compared with the previous year (654.3 billion Yuan in 2006). As a result of rapid economic growth in this period, households' income increased dramatically in very short period, which accompanied by a radical social transformation. Today, Urumqi becomes to the major economic and commercial centre in western China.

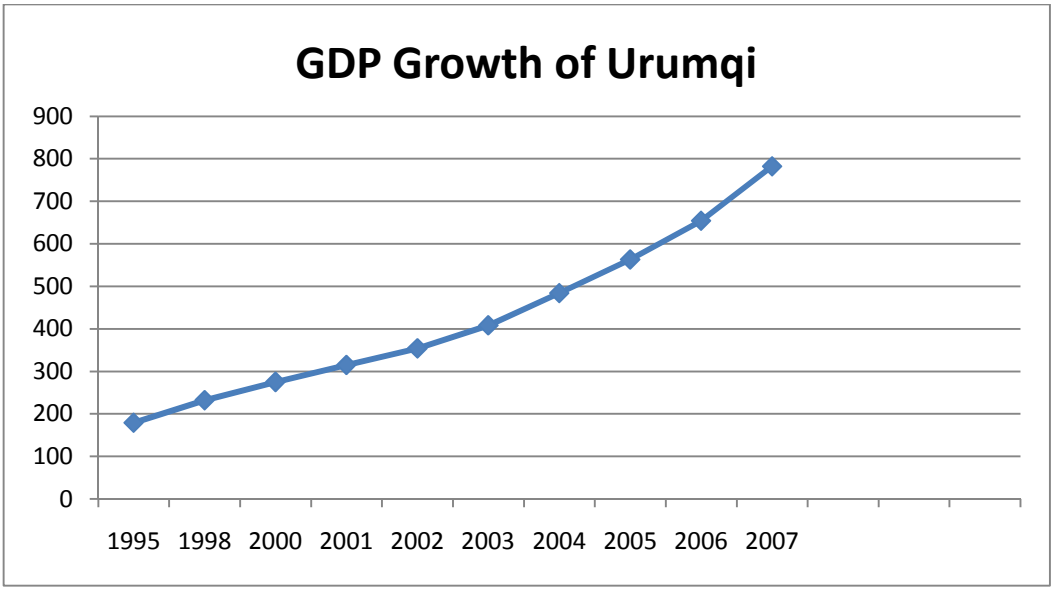


Figure 2. GDP growth of Urumqi, 1995 – 2007
Source: adopted from (Annual Report Urumqi, 2005 p. 34) and (Annual Report Urumqi , 2007 p. 28)

In the meantime, municipal garbage issues became to a serious problem as a result of adopted industrialization and urbanization processes. Skyrocketed figures of GDP growth present more disposable income of the whole society. However, the other newly emerged problems, especially the negative impacts on environment are challenging the capability of local administrations to choose adept strategies adopting sustainability in urban development. As one of the basic infrastructures in modern urban construction, a functional municipal waste management system necessary in order to deal with increasing amount and stress of MSW, which caused by rapid increasing of population and their material consumption, must be a prior considerable strategy for the local government.

2.2 Geographical Position and Metrological Condition

The largest city in the western half of China — Urumqi is situated in the north of Xinjiang Uygur Autonomous Region, geographical coordinates: longitude 86°37'33"-88°58'24", north latitude 42 ° 45'32"-44 ° 08'00". It stretches over 190 kilometers from east to west and 153 kilometers from north to south. (Annual Report Urumqi , 2007 p. 22) The city lies at the foot of the snow-capped Tianshan Mountains (or Tengritagh which means Mountains of god or heaven in Uygur language), bordering southern edge of the Junggar Basin. Administratively it borders the Changji Hui Autonomous on western and eastern, the Bayingolin Mongol Autonomous Prefecture on south, and the Turpan area on south-east. Urumqi is surrounded by the mountains, where mountainous area accounts for more than 50 percent. The average elevation is 800 meters above the sea level in urban area. (Li, 2007 p. 134)

In terms of a macroscopic perspective, Urumqi lies in the center of the central Asian desert region, has a typical dry continental climate. It has very little precipitation of 235.9 mm in 2006, (Annual Report Urumqi , 2007 p. 22) but a high level of percolation and evaporation of 2,266 mm. (Li, 2007 p. 134) Glacial melt water, surface runoff and underground runoff, as well as precipitation are the main sources of water supply in Urumqi. Total reserved water amount accounts for 12.22 x 108 cubic meters, of which the quantity of surface water is 11.76 x 108 cubic meters and

the quantity of ground water is about 5.55 x 108 cubic meters. (5.09 x 108 cubic meters measured by both sources). Water reserve per capita is 673 cubic meters, which is only equivalent to 29.3%.of the national average level, (2300 cubic meters in 1995). (Li, 2007 p. 147) Urumqi is a typical city locating in semi-arid area, which has limited access to ecological resources and suffered from water scarcity. It's the major reason why Urumqi is extremely vulnerable to climate change, which refers not only to disasters that caused by extreme events, but rather more "includes risk from less direct impacts", (Satterthwaite, et al., 2009 p. 19), such as declining water availability for livelihoods and industries.

2.3 Environmental Condition and Problems

2.3.1 Air Condition

Urumqi is among the handful of cities in China having worst air pollution, which was blacklisted in 2008 by the central government as one of the most polluted cities in China—with both severe air pollution and low quality water. (MEP, 2007 S. 11) In addition, Urumqi is also a regular caller with high ranking in international studies over cities worldwide which are suffering from heavy air pollution. (World Bank p. 175) Air pollution became one of the most important factors contributing to poor health to Urumqi's inhabitants beside climate conditions and access to health care, which causes serious health problems, including lung cancer, asthma, cardiovascular disease etc. Due to the lack of pollutant capture technology in place on most Chinese coal power plants and limited use of cleaned coals, Chinese coal burning produces environmental hazards. In Urumqi, coal is the primary fuel for power plants, steel mills, industrial boilers and domestic heating. In winter, during the heating duration, — usually from November until February next year, releases NO_2, SO_2 as well as other dangerous matter in high doses for over four months. Generally, SO_2 is the primary pollutant, only in November it is replaced by inhalable particles. (Annual Report Urumqi, 2005 pp. 148-149)

In addition, meteorological condition plus mountainous terrain which closely surrounding Urumqi have made environmental problem even worse, by creating so called temperature inversion in the atmosphere over the city. Especially in winter, when the angle of the sun is very low in the sky, inversion layers emerged in more than 89 percent of all winter days. When the phenomenon happens, it works with surrounding hills together to create a "bottle-caps effect", which makes the air become stiller, so that dust and pollutants are no longer lifted from the surface but trapped there, form a brownish haze in the atmosphere which causes respiratory disease. The average deep of the inversion layers in Urumqi reaches around 758.9 meters. (Li, 2007 p. 135) In days there are no rain, snow or winds; it is hard to dilute atmospheric pollutants by natural force.

	IP		SO2		NO2	
	2004	2003	2004	2003	2004	2003
Average Annual Concentration	0.117	0.127	0.106	0.097	0.058	0.055
Grade II national standards for air quality	0.10		0.06		0.08	
Excess of the Standard in Percentage*	17	27	77	62		

Table 3. Primary Pollutants in Urumqi
Source: (Annual Report Urumqi, 2005 p. 148)
***Standard: Grade II national standards for air quality in annual average, "Ambient Air Quality Standard" (GB 3095-1996)**

2.3.2 Municipal Solid Waste

In Urumqi, a large quantity of MSW is produced every year. Many of waste have not been safely treated or disposed because of technical and functional restrictions. MSW are usually mixed dumped and collected in China, and most of which are

terminated in landfill disposal sites. In recent years there has been a tendency toward rapid increasing amount of MSW generation in most urban area in China, including in Urumqi, more and more existing landfill disposal sites have been overloaded or will be soon filled up in visible further. As a result, “Garbage-surrounded City” becomes a hot spot of society which shows not only the raising public awareness concerning their living surrounding but also indicates the reality that MSW problem has greatly restricted the further urban development.

The risk overall in urban areas is “typically associated more with vulnerability than with hazard exposure.” (Revi, 209 p. 311) The first step in pursuing an adept MSWM system might be adopting a necessary and appropriate regulatory framework, which is on a par with international standards with respect of technical capabilities, while is also able to be integrated with the current economic and social goals. The government has made great effort on promoting environment related laws and regulations, implementing environmental standards on contractual projects, but legislative works still lag behind the economic development.

3 Regulatory Framework for Municipal Solid Waste Management in China and Urumqi

China’s authorities in government became conscious for the first time of the environmental pressures and problems that caused by increasing amount of MSW was mere since the beginning of 1990s, —10 years passed after the national economic begun to growth rapidly due to the implementation of “reform and opening” policy. However, the government successively promulgated a series of laws, regulations, policies as well as various assorted technical standards and specifications in the recent 20 years, in order to standardize and promote processes in prevention and treatment of MSW. In 1992 the State Council promulgated the "Municipal Provision on Environmental Sanitation ", in purpose of "resolving the problem of urban solid waste", which was proposed by the Ministry of Construction and other departments, first time incorporated the issues of MSWM into urban planning and construction system formally. By 1994, China merged the “development strategies for prevention and treatment of MSW” into the "China's Agenda 21"; According to the “Law of the People’s Republic of China on Prevention of Environmental Pollution caused by Solid Waste” promulgated by NPC, pollution prevention and control of MSW was involved as an important component of basic national policy. In 2000, the Ministry of Construction associated with other national administrative departments issued the “Technological Policy for Treatment of Municipal Solid Wastes and its Pollution Control”, specified in the new millennium the technological alignment and countermeasures to manage MSW problems.

In this chapter, I am going to at first introduce several legislators and central administrative departments, who are responsible for establishing legal framework to environment protection in China. Besides, functional differs towards different departments will also be formulated. Then it is also necessary to highlight some important laws and regulations for environment protection, especially for MSWM, which are adopted at both national and local level.

3.1 China´s Legislative System of Environmental Laws and Regulations

It is well known that China' legislative proposal is not born from the principle of "checks and balances". Acutely the Legislature system and procedure in China is quite different than in other lands. A number of factors might be accountable for this situation.

Firstly, in China, there is no single legislative body or even a single exercise of political power; therefore it does not belong to a single legislative system.

Secondly, the legislative power could be exercised by two or more organs of state power, which means that China has a diversity of legislative power, such as national legislative, administrative regulations or local laws and regulations, which were exercised by different organs of state power. This indicates not only that one legislative power could be divided into several organs, but rather the different administrative organs own legislative power at the same time. Therefore, it is neither a kind of multiple legislative system.

Finally, as mentioned above, the legislative system doesn't belong to a "Check-and-Balance-of-Three-Powers" system either. For example, the State President and Prime Minister are all nominated by National People's Congress (NPC), the State President could then only promulgate new laws based on NPC's decision, the Prime Minister has no right to approve or reject the power of the NPC's legislative and administrative regulations; laws and regulations at local level shall not contravene the laws and administrative regulations that promulgated by NPC. Meanwhile, the NPC owns the right to revoke or nullify the administrative regulations and local laws and regulations, which contradict the laws that enacted by themselves. All this indicate that China's legislation within the system's affiliation, the unity between the supervision relationships, does not indicate the relationship between checks and balances.

According to those characteristics of china´s legislative system, the laws and regulations, not only general laws, but also those relating to the environment, can be roughly classified into three categories, as outlined below,

- Laws proposed by NPC, the regulations and administrative documents promulgated by State Council
- Ministerial-level issued special laws and administrative regulations
- Regulations and rules issued by local government

In a word, many central government organs such as NPC or state council, the ministries and commissions, even the local governments as well, possess legislative powers at different levels. Among which, NPC possesses assembly the highest legislative powers.

3.2 National Institutions for Environment Governance

Environmental protection has been generally regarded as inevitable responsibility and fundamental function of the government. In this field, a government-dominant and society-relied pattern comes into being. (Li, 2003 pp. 6-8) There are long-established laws and regulations governing environment related activities and issues, and also a number of sector-specific regulations and institutions covering areas such as urban construction or MSW.

At national level in China, there are three important ministry level departments in charge of environmental affairs, i.e. the “Environmental and Resources Protection Committee” (ERPC), the “Ministry of Housing and Urban-Rural Development” (MOHURD) and the newly “established” “Ministry of Environmental Protection” (MEP).

3.2.1 Environmental and Resources Protection Committee

The committee ERPC was founded on 29.3.1993 of the 8th National People’s Congress. It is under the leadership of the NPC and its “Standing Committee”,

responsible for environmental law drafting, monitoring and examining environmental laws and regulations issued by local government. It owns in substance the highest legislative authority for national environmental issues.

3.2.2 Ministry of Environmental Protection (MEP)

The ministry MEP is the core administration for the environment protection in executive, who is subordinated directly to the State Council. On the 11th NPC at the beginning of 2008, the former Environment Protection Bureau (EPB) was reshuffled to a ministerial level department —MEP, indicating that the government begun to set higher store by environmental affairs, because of increasing concerns on environmental protection. It would make series of far-reaching consequences on formulating environment policies and implementing environment-friendly strategies supporting sustainable development.

MEP is functionally responsible for establishing and improving the basic pattern of environmental protection, formulating and developing various types of environmental protection standards, benchmarks as well as technical specifications, leading local MEP for supervising and managing the environment pollution prevention and controlling. In addition, MEP stands for an institutional body giving s technical standards and specifications for MSWM practices, such as standards for construction of landfill disposal plants, method of environmental impact assessment etc. It is also issued as regulator for necessary authoritative clarity in terms of environmental activities or violations.

3.2.3 Ministry of Housing and Urban-Rural Development (MOHURD)

The ministry MOHURD is another very important ministerial administration in China, playing an important role in dealing with many environmental affairs, especially in the MSWM. It takes at the same administrative level with MEP, and both of them are governing MSW issues cooperatively.

China's current MSWM is essentially carried out by the urban sanitation departments. However, other participants are also involved in different realm of the management system requiring specified institutional functions. Generally, the construction

departments are in charge of the urban waste management; while environmental pollution or problems caused by waste treatment or waste disposal are delivered to the environmental protection departments. Sanitation sectors are usually subordinated to GOHURD of the next higher level, taking over various MSWM tasks, such as collection, transport and treatment etc.

Therefore, MOHURD has been in fact taken over more concrete tasks in MSWM than MEP has, as it is functionally responsible for the urban planning and construction, especially for the amenities and sanitation projects. Cooperation is needed between MOHURD and MEP in different levels. For example, the local MEP are physically not subordinated to MOHURD, however in practice, it's their duty to complete the environment related assignments which are ordered by the MOHURD on the higher level as well.

3.3 Grasping Important Laws and Regulations in terms of MSW

MSWM can be only adopted successfully in an institutionalized process, which standardized by legal norm and regulations, as well as other supporting technical standards. In recent 30 years since 1979, China has met a codification booms for environmental protection, so that the year 1980 was called as a "founding and development phase of China's environmental law". (Chen, et al., 1997 p. 90)

However, this has so far been characterized, — in contrast to Western Europe, Japan and the United States, almost exclusively by a top-down approach. Later 1990s, the concept of environmental awareness has been realized and introduced by Chinese government as the cornerstone developing modernization. (Küchler, et al., 2004 p. 126) China didn't have a real important special legislation for MSW until 1995. "Law of the People's Republic of China on Prevention of Environmental Pollution Caused by Solid Waste" was promulgated in 1995 by NPC. It is the fundamental law and the guidance for the MSW treatment and disposal. Since the day it was released, the codification of the laws and regulations for MSW developed rapidly, including

ministry and local rules and regulations, specific regulations, and other supporting technical standards.

3.3.1 MSW Laws and Regulations

Some most important MSW laws and regulations in China are showing in table 4. Most of them were promulgated by NPC, MEP or MOHURD. These laws build the steady roof of the whole legal framework in MSWM. They are passed as the guidance programs in the environmental legal system. I will give a brief introduction in this subchapter.

"Environmental Protection Law of the People's Republic of China" (EPL), which was released in 1989, is the fundamental law of the environmental protection and policy in China. The other individual environmental laws and regulations are all based on it, as it prescribed the comprehensive principles on major issues in matters of environmental protection. Aimed at "protecting and improving people's environment, preventing and controlling pollution…" (Article 1), "the competent department of environmental protection administration under the State Council should conduct unified supervision and management of the environmental protection work throughout the country." (Article 7)

The most important law in matters of MSW is the "Law of the People's Republic of China on Prevention of Environmental Pollution caused by Solid Waste" (PEP). It was released in 1995 by NPC and based on the major legal principles abstracted from the EPL. As a specific law for MSW, it stipulates three most important principles in MSWM, i.e. "Minimization" (implicit prevention and reduction), "Recycling" (reuse and recovery) and "Decontamination" (refers to innocent processing) of the solid waste. (Article 3) PEP also emphasized the "polluter pays principle" and reiterated extended producer responsibility, i.e. "In preventing and controlling environmental pollution by solid waste, the State follows the principle whereby the polluter is held responsible in accordance with law." (Article 5)

Laws and regulations	Promulgation Institution	Date of Promulgation
Environmental Protection Law of the People's Republic of China (EPL)	NPC	12.1989
Law of the People's Republic of China on Prevention of Environmental Pollution Caused by Solid Waste (PEP).	NPC	10.1995; 12.2004
Municipal Provision on Environmental Sanitation	NPC	06.1992
Administrative Measures for Urban Living Garbage	MOHURD	08.1993
National City Environmental Sanitation Unified Labor Quota	MOHURD	1996
Notice on Implementation of Urban Living Garbage Disposal Fee System for Promoting the Industrialization of Waste Treatment.	NDRC, MEP, etc.	2002
Implementation of urban environmental sanitation measures current industrial policy	MOHURD	09.2001
Notice on Further Promoting of Comprehensive Utilization of Resources	NDRC	08.1996
Index of Comprehensive Utilization of Resources	NDRC	2008
The National Hazardous Waste Inventory	NDRC, MEP	2008
Technological Policy for Treatment of Municipal Solid Wastes and Its Pollution Control	MOHURD MEP, CAS	05.2000
Circular Economy Promotion Law of the People's Republic of China (CEP)	NPC	01.2009

Table 4. Municipal Solid Waste related policies, laws and regulations in China

In revision of PEP by the end of 2004, several new choices of representations appeared in the context indicate the new tendency in the environmental policy. Instead of "facilitating the development of socialist modernization" it comes "promoting the sustainable development of the economy and society" (Article 1); and a new statement has been added "in order to promote cleaner production and the development of a circular economy" (Article 3). The calibrated key words "sustainable development" and "circular economy" represent together the new direction of the integrated development of economic and environment in further. More important, this new idea does not stick to the meaning of rhetoric solely; another recently released environment law aimed at promoting circular economy made the new concept thoroughly followed out.

On the 11th NPC in August 2008, the law of "Circular Economy Promotion Law of the People's Republic of China" (CEP) was passed, and came into force upon the 1th January 2009. The proposal of this legislative bill has a significant meaning of guiding MSWM in further. It posed clearly that the goal of further economic development is aiming at "promoting the development of recycling economy, improving the efficiency of resources utilization, protecting and improving environment, and promoting the changes of economic growth pattern, as well as realizing sustained development." (Article 1) To achieve this goal by promoting "recycling economy … refer to all the waste reduction, reuse and recycling carried out during the process of production, circulation and consumption." (Article 2)

According to CEP, the "recycling economy" should be adopted as "a far-reaching strategy of the state for economic and social development" (Article3). We could foresee that as long as CEP truly adopted, it will make a far-reaching consequence on for example the Standardization of Production, formulating the directory of MSW or recyclable producing processes, and the further sustainable policies about MSWM. In addition, it made a fundamental change in understanding of environment, which promoted from powerful top-down channel, however, will also change the way of life of the ordinary citizens in a certain extent, like promoting the efficiency in consumers and resources consumption, or increasing the aware of protecting and improving the environment.

3.3.2 Fundamental Principles abstracted from MSW Laws and Regulations

There are implicit and explicit principles abstracted from MSW related laws and regulations, which orientate and rule the legislation and judicial interpretation. Although in practice, environmental laws and regulations in China is more rule based than principle-oriented. These principles also establish obligations in the individual's behavior that belongs to the environmental field in which such activities and motivation of those behaviors are accepted.

The first important principle is “Polluter-Pay-Principle” (PPP), which is one of the worldwide universal used principles in environmental laws. It is not written down in the EPL or the old version of PEP, but was added in the revision of PEP by 2004. According to (PPP), the polluter is responsible to bear the repair costs of the pollution. (Lü, 1997 p. 62)

Recycle, Reuse and Reduce, the so called 3R concepts is the cornerstone of the waste hierarchy based on the desirable strategies in the waste management. In China, this principle has been adopted since a long time while with some bias in the understanding. China’ waste management policy emphasized more of “san hua” which is similar to 3R, but maybe with a better translation of “Minimization”, “Recycling” and “Decontamination”. Minimization could equally be termed waste prevention, that waste being produced in the first place should be reduced. Moreover, it also refers to decline the negative impacts of discharged MSW through implementation of appropriate techniques or adept management processes. (Wang, et al., 2007 pp. 116-117) The twofoldness in this principle indicates that not only the quantity of MSW should be minimized, but also sequent influences. As general accepted concept, which is considered as most efficient one, recycling refers to the activities considered as “green” waste management, like reuse and recovery, which comprise activities pursuing material, resource and energy recycling. For residual waste, that could not or temporally not be recycled, applying a variety of techniques and methods of environment-friendly or low harmful handling or discharge, so that solid waste will do no harm to human health, and do not cause pollution to the surrounding environment, such a process is called “Decontamination”. (Wang, et al., 2007 p. 117) The three principles are equally proposed, however, in the practice,

Chinese government emphasized more on post-protection, which causes directly the less respects for the source reduction and recycling process. As a result, the MSWM sticks to a mode based on a non-circular economy, with more efforts on passive discharge of MSW.

Another very important principle is the subordination of environmental protection to economic development. According to the statements in "Beijing Declaration" 1991, as one of the developing country, China would not because of environmental reasons to give up the economic development. The core point of Beijing Declaration is that in the integration of environmental protection with economic development, the latter one should be prior considered. (Richter, 2002 p. 33) For example, the large-scale urbanization happened in short time could bring lots of unexpected impacts and stresses to urban structure, leading to various vulnerabilities to both local inhabitants and new immigrants. However, if the urbanization is necessary for economic growth, it could not be overridden due to the environmental or social impacts. In recent years, adopting environmental impacts assessment might be a positive signal for change, but until now, there is still no clear statement presenting the priority of environment protection in any of national environmental laws.

3.3.3 Environmental Standards and Technical Specifications

MOHURD, associated with MEP and CAS, has released “Technological Policy for Treatment of Municipal Solid Wastes and Its Pollution Control” in 2000, in which they recommended strategies and programs as guidance for the MSW treatment and management, including technology-based standards and specifications on construction, operation and closure of sanitary landfills disposal sites and incineration, etc. Compost and recycling are strongly recommended as considerable MSW treatments with respect of available technology and potential feasibility. A series of regulations to support those treatments could be divided into following two groups:

- Environmental Standards
- Technical Specifications

In addition, there are also special regulations for the medical and hazardous waste. Environmental laws and regulations as well as mentioned environmental standards and technical specifications build up together the fundamental pattern of China's MSWM system.

3.3.4 Important and Special Laws and Regulations in Xinjiang und Urumqi

As mentioned before, the local environmental legislation is also a major supplement in building of the whole environmental legislative system, which has a nature advantage serving the local requirements. The local regulations focus on regional environmental characteristics, putting more emphasis on processing against local environmental weakness. Urumqi is particular vulnerable to environment impacts and sensitive to climate changes, who needs more legislative freedoms in proposing local environmental regulations to achieve its economic and social goals.

"Urumqi City Appearance and Environmental Sanitation Regulations", was released to regulate the common activities in MSWM, such as MSW collection and transport. Specialized regulations are also available for managing special kind of MSW, like "Urumqi Urban Construction Waste Management Regulations", provided regulations and specifications for construction waste management. In addition, Local administrative departments are also able to promote regulations for other special issue in terms of MSWM. Urumqi Urban Amenities Administration has released the "Plan for bounded Collection of garbage treatment fee and water fee in Urumqi City" by 2007, proposed a new MSW pricing system relating to domestic water consumption to promote PAYT pricing program.

3.4 Problems and Recommendations to Environmental Laws and Regulations

China has been throughout a codification booms on environmental laws and regulations in recent decade, which helped the government making a series of success in environment protection. However, the established regulatory framework so far is showing more and more incapability in dealing with the negative impacts

due to proliferated productive and economic activities. In fact, the environmental problems are getting worse than one or two decades before, most of the degradation due to unrestricted human activities. Besides, the improvement and revision of the existing legislations are also necessary, as considering the rapid economic and social transition, some legislation cannot fit the current situation anymore.

The release of “Circular Economy Promotion Law” is a good attempt in direction developing efficient economy to achieve sustainable development. However, it requires a series of subsequent specific laws and regulations to embody material flows in a recycling process as well, including laws for packing waste or disposable goods etc.

The position of government in MSWM has to be changed in further. Caught in a contradictory position as both promoter of economic development and as environmental regulator, government often engages in a process of “environmental managerialism”, in which they attempt to legislate a limited degree of protection sufficient to deflect criticism but not significant enough to derail the engine of growth.

4 Quantity and Essential Composition of MSW in Urumqi

The problem of MSW is diverse. In this chapter, the historical quantity development of MSW will be reviewed at first, which has been developed over time, affected by two significant factors, the population and the gross domestic product. The composition of MSW is differing from locations, which is resulted by many variable factors. In practice, the majority waste from households comprises both organic and non-organic material. In addition, increasing quantity of MSW requires more expenditure on domestic waste management, caused a reform pricing system for MSW in Urumqi.

4.1 Overall Quantity of MSW in Urumqi

4.1.1 Overall Quantity Development of MSW Since 1990s

MSW generation is inevitable where human activities happen. Therefore, a review of quantity could be traced back to ancient time when Urumqi city was established. However, I am just going to present MSW quantity growth in recent 20 years due to following considerations.

Firstly, the reliable data provided by the local statistic agencies are only available since early1990s, as the MSWM was issued only since recent years. Before and even after 1990, informal factors kept playing an important role in MSW collecting and recycling, but no one could tell how much exactly they have been contributed. According to a report of BAS based on random interviews conducted with waste pickers in Beijing, there were estimated around 300 thousand waste pickers and collectors along in Beijing by 2003, who “pick” the waste worth more than three billion Yuan a year. (Jin, et al., 2006 p. 340) However, such approaches are

extremely restricted in Urumqi. Figures or statistics in Urumqi is not available and not included in the table below.

Secondly, we have more interests in quantity development caused by industrialization and urbanization process in Urumqi, consequent by “reform and opening” development strategy and massive investment in the infrastructure since begin of 1990s. (Dillon, 2004 p. 37) Increasing investments as well as huge benefit of trade with middle Asian States promoted local economic growth and domestic consumption volume rapidly. A large number of new immigrants have been attracted from rural areas into booming urban market, while the urban population increased dramatically. The quantity of MSW generation also increased fast during this period, indicating a strong dependence on GDP development as well as population growth.

An overview in terms of quantity development of MSW in resent 20 years has been illustrated in Table 5. Instead of the quantity of MSW generation, the figures in the table refer to collected quantity by public factors. The quantity of MSW generation is defined as the amount of solid waste that generated by the residents in their daily life or social activities, within a certain region; while the collected quantity of MSW refers to the quantity of MSW that have been cleared or collected (by public factors) in a certain region. (Du, et al., 2006 p. 86) We use therefore the figures of collected MSW to study the tendency of quantity development, despite the discrepancy comparing to the total quantity caused by informal collection.

540 thousand tons of MSW have been collected by 1996; while the number of 2006 increased of 750 thousand tons, with 40% increment in ten years. (See the middle column in Table 5) It is showing a clearly increasing tendency with a yearly growth rate around 3.34% during this period. Except for the slight decline in 2001 and 2002, the quantity of MSW increased continuously over ten years.

Unite: 10,000 tons

Year	MSW	MSW Total ①
1992	—	59
1995	—	82.6
1996	54	88
1997	58	92.6
1998	61	—
1999	66	—
2000	67.9	126.5
2001	67	110
2002	62	108
2003	66	117
2004	69	127.7
2006	75	154
2007 ②	36	92.7

Table 5. MSW Growth in Urumqi, 1992 –
Source: Annual Report Urumqi, 1993 - 2008
①: MSW Total includes MSW from households and construction waste;
②: The data by 2007 refers to the quantity that has been discharged in sanitary landfills

It turns out the same tendency if we follow the quantity growth of total MSW, including construction waste. (See the third column in Table 5) There was only 590 thousand tons by 1992, roughly equal to the same level with households generated

MSW in 1996. Up to 2006, it increased by 160 percent, to 1,540 thousand tons. The rapid increasing of MSW was accompanied by the industrialization and urbanization process in the city, caused by the growing production and consumption of expanded population and increasing purchasing power.

In addition, the quantity of MSW, especially the statistics also depends on what kinds of MSW have been collected. Some typical MSW are not included in Table 5 as they are generally not collected by formal factors. For instance, the disassemble wastes, like furniture and households electric appliances are always collected by ambulant waste collectors; used vehicles or scrap tires are also not included. Part of “profitable” waste like PET bottles, papers etc are collected by waste collectors as well. The statistic for this part of MSW is complex as the waste collectors do their job not only before the intervention of public factors but also after ´the collected MSW have been discharged in the waste dumps. In addition, waste collectors could sell the collected waste direct to producers, who need recyclable material for further production, or they could also forward it to the public recycle sits. An approach of informal factors will be introduced in later chapter.

4.1.2 Correlation with GDP Growth

In recent years the quantity of MSW generation worldwide indicated an upward trend as well. The average growth rate accounted for approximately between one and three percent per year. There are some traceable indicators in MSW generation showing similarities in different counties, for instance, the industrialized countries generate usually more MSW then developing countries, due to higher consumption level. Within the developing countries, MSW generation increases superproportionally, when the country is experiencing a rapid developing or in huge economic transition. (Li, et al., 2009 p. 4)

The quantity of MSW generation overall in China was of 106.71 million tons in 1995, and has been grown to 195 million tons in 2005, (Wang, et al., 2007 p. 10) increased totally 83.96% in 10 years with an annual growth rate of 6.3%. In the meantime, the

GDP developed from 5,847.8 billion to 18,308.3 billion Yuan in the same ten years period, by 12.09% per year.[3]

	MSW	GDP
China	6.3%	12.09%
Urumqi	3.34%	12.14%

Table 6. Comparison yearly growth rate of MSW and GDP in China and Urumqi, 1995 – 2005, own design

Through the economic and MSW development comparison with China's average level, we see that during the same period, the yearly growth rate of MSW of Urumqi accounts for 3.34% per year equals to half of the national average level. However, the GDP has been grown with a rate of 12.14% per year, which is even higher than national average level. Under the similar economic developing speeds the quantity of MSW generation in Urumqi growth much slower than China's average growth level. The rational economic development didn't affect MSW quantity development might be caused by following reasons.

First of all, the biggest contribution of MSW generation is coming from households' consumption, depending on their purchasing power or disposable income. These factors are not equal GDP alone, but they also hinge on how the produced GDP has been distributed among economic sectors. "Gini Coefficient" is one of the most commonly used measurements for identifying inequality of income and wealth. "Gini Coefficient" in Xinjiang reached 0.4437 by 2005, (Wang, et al., 2007 p. 18) interpreting a high level of income disparity among the population, so that poverty and low purchasing-power level still dominant the majority of the population, despite the fast growth of the total domestic income. As a result, domestic demand on consumer goods stagnated at low level, making only few contributions to the

[3] According to modified figures published by National Bureau of statistics of China, online available via http://www.stats.gov.cn/english/statisticaldata/yearlydata/

economic growth, which is determined in essence by accelerated growth of domestic investment or FDI, which rose sustainably since early 1990s. (Huang, 2003 p. 3) In a word, GDP growth makes only indirect influence on MSW generation, and it doesn't always indicate a positive relationship between two factors.

As long as the industrialization and urbanization process that adopted in recent years the living condition of non-Han ethnic groups did not change significantly, or not so much as to Chinese-Han people. Due to the ethnic complexity that we already talk about in former chapter, the differences in language, culture, religion and customs separate the Chinese-Han people and non-Han people in space. For instants, even in urban area, most of Uyghur living in the near of "Bazaar" in Urumqi, where few inhabitants of Chinese-Han people. Uyghur would rather live together to keep their traditional way of life. In addition, there exists obviously still an ethnic income imbalance, as a result of an apparent ethnic division of labor in Xinjiang, to the extent that Chinese-Han predominate in most large cities and primary industrial and business sectors, so that the consumption also higher in the overwhelmingly Han cities. Han migration and income disparities are not only said to be the chief source of resentment among Uyghur, causing political unrest in the region, but also proliferated increasing economic and social problems. (Sautman, 2000 pp. 439-440).

Secondly, in developing countries, including China, it is normal that public sectors collect only part of total MSW and what percentage would be collected is generally not clear. The existence of informal sectors is indispensable for waste collection, but it is also invisible in the data acquisition. Currently there are no scientific studies and reliable data over informal market in Urumqi.

The last but not the least, the special industrial structure of Urumqi, that dominated by trade and service business, causes the low MSW generation growth rate. As it' been illustrated in the following graph, the proportional contribution of agriculture, industry as well as service and trade to total GDP in 2007 is "1.28: 37.72: 61", (Annual Report Urumqi, 2008 p. 31) the tertiary sector of the economy has made the greatest contribution to the local GDP growth, which is not exactly as it looks like in developing countries, and is also much higher than the national average level of 42.3%

in the same year.[4] Service sector in Urumqi has been developed much more quickly than other economic sectors. The local government has made a great effort on developing multilateral trade business with neighboring countries, especially intertwined with the post-Soviet central Asian states, because of their close geographic and ethnical resemblances. In contrary, the secondary sector (approximately manufacturing), which would be engineering more job opportunities and manufacturing more finished goods located is dominated by tertiary sector in Urumqi.

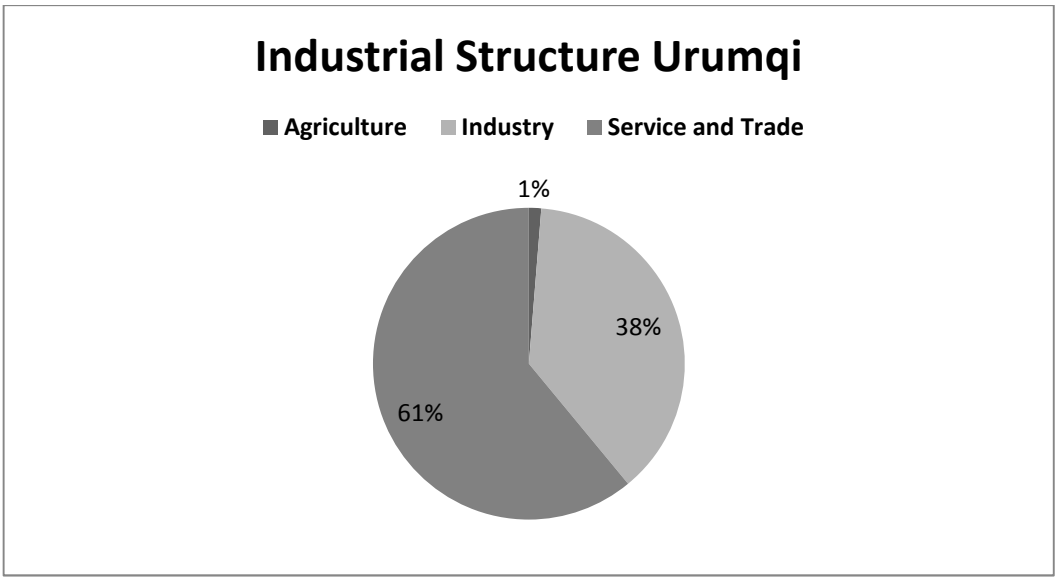


Figure 3. Industrial Structure Urumqi
Own design according to (Annual Report Urumqi, 2008 p. 31)

4.1.3 Correlation with Population Growth

Since 1949, the population size of Urumqi has enlarged remarkably. However, the reasons for population development in different periods were not same at all. The fastest development of population took place during the first 10 years after the founding of the People' Republic in 1949, as a result of the national immigration policy. The population grew around 6.5 folds in this period, with a yearly growth rate

[4] According to National Bureau of statistics of China, online available via http://www.stats.gov.cn/english/statisticaldata/yearlydata/)

of 23.46%, which was much higher than any time in history. Along in 1960, the net immigration outcome was 76 thousand people. The population has been tripled in this period, which did not only enlarge the size of total population, but also increased their proportion in the whole population. Chinese-Han population is although still minority in Xinjiang today, however, they became to the second largest minority group in the region, and increased sustainably since then.

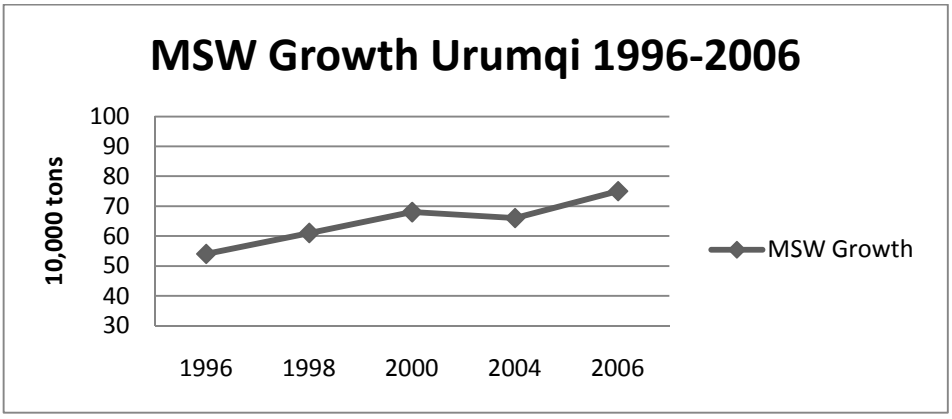
During the following 20 years until the end of 1970s, the population development entered a natural-growth period. Urumqi stepped into a metropolis with one million inhabitants by the end of 1978. In the recent decade, annual population growth rate remained at the level of 2%, slightly lower than the China's annual growth rate of urban population of 2.33%, between 1990 and 2000. (McGranahan, et al., 2009 p. 68) According to the fifth national census, Urumqi had an urban agglomeration in excess of two million, reached 2.08 million by 2000. (NBSC)

Most of the cities in China are still proceeding of urbanization sequent rapid economic expansion and large shifts in employment patterns from agricultural activities to industrial and service activities. Urumqi is without exception any way. The immediate cause of urbanization is the net movement of people from rural to urban areas. The main underlying cause is the concentration of new investment and economic opportunities in particular urban areas. Urumqi is a typical metropolis with "big urban" and "small suburban, administrating seven districts, which make up the central area of the city, and only one county. (See chapter one) The most of inhabitants are living within the four core districts, "Tianshan District", "Saybagh District", "Xinshi District" and "Shuimogou District". In 2002, the population in these four districts accounted for 80.33% of the total population in Urumqi. In contrary, the population in suburban has been continued to decline. For instance, from 1990 to 2002 the population of Urumqi County reduced by 48%. Except a part of them have been transferred to "Daban District", most of people immigrated initiatively to the urban area. Therefore, the expansion of urban remains the main reason that increasing people choose to live in the inner city. (Du, 2006 S. 96-97)

Comparing MSW growth with population growth in Urumqi during 1996 to 2006, it's showing clearly upward curves in both following graphs. The quantity of MSW generation increased from 540 thousand tons by 1996 to 750 thousand tons by 2006,

which was around 1.4 times as much as ten years before. In the meantime, the population also increased from 1.5 million to 2.3 million with an increment of around 50% in ten years.

In the first 5 years since 1996 the population increased rapidly. Consequently, the MSW growth curve in this period is showing a continuous upward movement as well. The slight decline of MSW quantity during 2000 to 2004 might be accordingly caused by the population change, as the population growth was also stagnated in this period. Since 2004 the population was mounting up steadily, while MSW quantity continued to grow fast again. According to graph 4 and 5, there is an obvious positive relationship between two observed factors between 1996 and 2006.



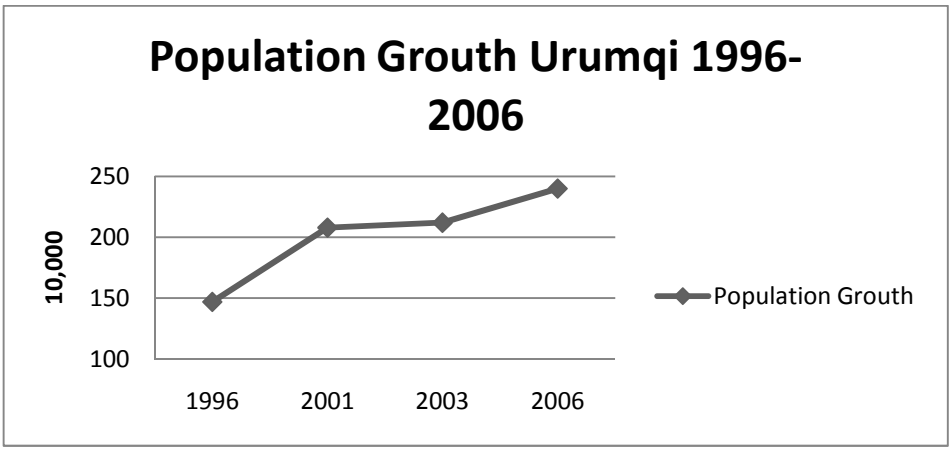


Figure 4. MSW Growth Urumqi, 1996 – 2006 (above)
Figure 5. Population Growth Urumqi, 1996 - 2006 (below)
Source: Annual report Urumqi 1997 – 2007
According to Annual Report Urumqi 2007, the registered residential population in 2006 was 2,018,443, registered floating population was 389,000.

In addition to the net population growth, the shrink of the agricultural population and further extended urbanization also stimulated the growth of MSW quantity. As mentioned that during 1990 to 2002 the population of Urumqi County reduced by 48%. From 1998 to 2002, the net population growth in “Tianshan District”, “Saybagh District”, “Xinshi District” were respectively of 56, 200, 77,900 and 66,600. However, the population in Urumqi County decreased by 77,100 in this period. Extended urbanization causes not only more urban residents but also more “consumers” who are considered as the “producers” of MSW. This urbanization process, which is quite commonplace in developing countries, would still continue for many years, as long as more workforces are needed by industrial activities. In addition, urbanization is supported by government’s policies, which has been seen as the essential factor to achieve modernization. Besides, various of projects aims at urbanization and promoting the living level of county people are implemented or in planning by the local government, including extension of collection area to the rural and suburban regions, which will also cause the further growth of MSW.

In conclusion, the growing quantity of MSW in Urumqi since 20 years is caused essentially by the development of population. (especially the immigration of non-agricultural population)

4.2 MSW Composition and Classification

The composition of MSW is quite complex, sequent the panorama of city life, influenced by many different factors, such as natural condition or meteorological situation, inhabitants’ behaviors (especially the diet) and energy structure etc. Therefore, the composition of MSW vary from country to country, region to region. Even the composition of MSW generated in one city could be different due to the observation time. There are general common grounds in the mass, but it always indicates a strong randomness in deferent regions as well.

In essence, the MSW are generated by social and economic sectors, such as household, public space as well as commercial and industrial (C&I) enterprises. The

composition of MSW from different sources differs as well. Households MSW are highly related to the daily life of ordinary inhabitants. It includes a large amount of the residual substance of households commodities, which is the largest part of the MSW in China, accounting for about 60% of the total amount, and with a rather complex composition. MSW coming from public space or C&I enterprises accounts for 10% and 30% of the total amount respectively. The composition of MSW from different industrial sectors differs with each other due to different needs of activities. However, the composition of single institutional subject is generally much more stable than it is from households. (Du, et al., 2006 p. 88)

Source	Main Composition
Households	Food, Paper, Board, Wood, Metal, Glass, Plastic, Rubber, Ceramics, ash, broken brick, waste equipment, etc.
Public Space	Sand, Dust, Dry Twigs, Lost Leaves, Packaging, etc.
C&I Enterprises	Different from sector to sector

Table 7. Sources and Main Compositions of MSW in China
Source: (Du, et al., 2006 p. 88)

There is a couple of ways for classifying different components of MSW, depending on their physical or chemical properties, or how MSW would be ultimately treated. One of the typical descriptions of the MSW composition in Urumqi has been listed in Table 8, based on the physical properties of different components, including paper, plastics, glass etc.

Despite the item of brick and ceramic, which is mainly coming from the construction waste, the primary components of MSW is kitchen residual. Kitchen residual generally terms for the food residual produced or dumped by households, hotels, restaurants and C&I enterprises. (Hu, et al., 2006 p. 5) In essence, the dominant of kitchen residual is quite prevalent in China. It causes various technique difficulties in

MSW treatment due to chemical complexity. Besides, the sum of items like paper, textile, plastics, wood, metal and glass accounts only for less than 10% of the total amount. The item "Others" here is on one side referring to the components that not included in the scheme, while on the other side, it also comprises the quantity of other items, which have been already listed, however, the quantity terms them are incompletely gathered, if the collected quantity by informal factors is also accounted. Overall, it represents a prevailing scene of MSW composition in a typical city of China. However, comparing to the national average, we will see the discrepancy in the proportion that these components taking up.

Composition	Content %	Composition	Content%
Kitchen Residual	**15.22**		
Paper & Board	**2.53**	**Metal**	**3.3**
Plastics	**1.72**	**Glass**	**2.95**
Textile	**0.38**	**Brick, Tile and Ceramic**	**17.53**
Wood	**0.41**	**Others**	**55.96**

Table 8. Composition of MSW Urumqi
Resource: (Wu, et al., 2005 p. 159)

It is not hard to identify that the primary components of MSW in Urumqi are overall (except Metal and Glass) underlying than the national average level in percentage, if we take a look at the scheme below. The composition of MSW in a city is determined by various factors. The local consumption structure and environmental condition are considerable causations.

Consumption on products that produced by paper, plastics or textile reflects the level of economic development level. With higher disposable income the urban inhabitants are able to consume more commodities made of plastic, or goods with plastic

packing. Paper is mostly used in printed publications or by enterprises, while textile is important raw materials for manufacturing clothes or other daily necessities. The consumer goods produced by mentioned materials can be substituted by other inferior products or other materials due to price disadvantage. In essence, the less disposable income, the higher elasticity of substitution is. Industrialization as well as Urbanization processes in Urumqi started later than in other coastal cities in China. Consequently, if we compare the economic development in western and eastern region, disparities and inequalities appear large, and have been growing larger over time. (Keidel, 2009 pp. 541-543) Fewer perceived income limits the purchasing capability of inhabitants. As long as GDP and perceived income continue increasing, more goods made of plastic, paper and other materials will be consumed.

	Kitchen Residual	Paper & Board	Plastics	Textile	Wood	Metal	Glass	Brick, Tile and Ceramic
Urumqi	15.22	2.52	1.72	0.38	0.41	3.3	2.95	17.53
National Average	43.6	6.64	11.49	2.22	2.87	1.07	2.33	23.14

Table 9. Comparison of MSW's Composition in Urumqi with National Average in % Source: adopted from (Wu, et al., 2005 p. 159) and (Du, et al., 2006 p. 89)

The proportion of metal and glass is slightly higher than the national average level. Xinjiang is rich of natural resources and nonferrous metal reserve, the price of energy and raw-materials is quite cheap. In addition, Uyghur and other non-Chinese people prefer using more metal commodities in accordance with their nomadic tradition.

The reason why kitchen residual takes up only small proportion (compare to national average level of 43.6%) in total amount is quite complicated. First of all, Urumqi has

the longest warming period in China, — from October 15 to April 20 next year, 188 days in total. In addition, due to the competitive price advantage and vast reserves, burning coal is the main source providing energy for winter heating, which releases not only various noxious gases but also massive ash of coal, which contributes the majority part of MSW in winter. In contrary, in most of cities in south China, there is no heating period at all. As a result, in non-heating area, kitchen residual constitutes higher proportion in total MSW than it is in heating area, due to the absence of ash from coal burning. Generally, “in the coal area, only 25.19 % (of MSW) are organic matter, inorganic matter account for 70.176 %”. (Du, et al., 2006 p. 88) Kitchen residual is the main source of organic matter in MSW. It also explains why the proportion of other components is also overall more or less lower than the national average level.

On the other hand, a large part of kitchen residual from food business is very often collected by private waste collectors. The government of Urumqi has passed “Regulations on Kitchen Trash Treatment Urumqi” at the end of 2007, in order to strengthen the management of food waste which is mainly dumped by catering sectors like restaurants. Two years before that, in 2005, 16 million Yuan has been invested for building a “Food Waste Comprehensive Disposal Center” (FWDC), so that the catering waste could be centralized treated. However, according to a report by “Xinjiang Daily” in 2008 (5^{th} Mai), there were around 200 tons of kitchen waste that daily produced by more than 7,000 catering enterprises in urban area, while only 30 tons were collected and transported into this only one specific treatment center in Urumqi. The rests are reused for example as "swill-cooked dirty oil", which is usually made from discarded kitchen waste that has been refined, leading to serious hygiene problems. For example, adding "swill-cooked dirty oil" for food preparing, which contains a highly toxic and carcinogenic substance called "aflatoxin", can cause various severe disease, even cancer. (Quan, et al., 2004 p. 105)

4.3 Cost and Pricing

Currently in China, the entire process of MSWM including collection and treatment is performed by public sectors. Environmental health administrative departments at different levels are in charge in collection, transport, discharge and further logistical arrangement in terms of MSW, which are almost totally financed by government budget at different levels. The cost calculation will show the difficulties that local government is facing by providing MSWM service under current pricing and charging system. In recent years, drawing references from oversee experience, the polluter-pay charging programs have been adopted as experimental programs in many cities. However, it met more barrier problems in practice. Since September 2007, a new MSW charging program associated with water consumption level as a proxy variable has been released in Urumqi. This program is likely to be extended throughout the country in further to propose a practicable and cost-effective billing system for MSW charging.

4.3.1 Cost for Municipal Solid Waste Management Services

The cost ranges MSWM services refers to all the expenses on MSW managing or handling from “cradle” to “grave”, including costs of MSW collection, cleansing, disposal, transfer, and recycling etc. In addition, the investments and expenses for infrastructure construction or purchasing of required equipments and facilities are included as well. An approach on the total cost of MSWM is the essential prerequisites for MSW pricing, in order to establish and promote practicable and cost-effective MSW charging program.

There are two major sources of revenue of EHD. The national finance committed an appropriation of 41.57 million Yuan in 2004, designed for the maintenance and construction of environmental sanitation in Urumqi. Most of the fund had been expensed supporting daily work of EHD at all levels in Urumqi, including street cleaning and MSWM proceeding. The investment for fix assets was not included. While in the same year, there were extra 35.66 million Yuan allocated for infrastructure construction in terms of environmental sanitation in Urumqi, which would has been spent under the authority of local government. Actually, only 800

thousands Yuan has been invested on the infrastructure constriction of garbage treatment in 2004. (Fridley, et al., 2008)

On the other hand, there were 2.89 million Yuan as tipping fee has been levied in 2004 which would be used on the MSWM directly as well. (Fridley, et al., 2008) However, compare to the government appropriation, the levied tipping fee made up only a small section. The old charging system has been stumbled for long times, assailed by lower collection rate due to various enforcement problems like widespread non-compliance or free-ride behaviors.

The expense on MSWM includes following expenditure items. Collection and transport need the main capital outlay in MSWM. It includes expenditures on purchase price of vehicles and required facilities, fuel, operating and maintenance costs, as well as the payment of workforces. According to the relating references, total cost for collection C_c is about 55 Yuan/t; while the transport cost C_t accounts for 40Yuan/t. In essence, two-thirds of the MSWM costs are attributable to collection and transport service. (Yao, et al., 2009 pp. 141-142)

Disposal and discharge costs entail great expense in MSWM as well. For example, the Dapugou landfill is the single sanitary landfill in Urumqi, with the processing capacity of 2000t/d. We assume that the operating costs C_{tr} is of 60 Yuan/t, according to the requirement of the relating national environmental standard. (CAES, et al., 2007 p. 37) Thus, the cost under 100% operating is 43, 8 million Yuan/y. According to Table 5, the quantity of in sanitary landfill disposed MSW was 360 thousand tons in 2007. As there was no any other sanitary landfill in Urumqi, so barely the operating cost of Dapugou landfill accounts for 21.6 million/y. The price of MSW disposal in sanitary landfills will continue increasing, as long as more strict requirements for environmental protection imposed in further.

In addition, administrative expense is another major expenditure item which is responsible for governing and supervisory MSWM. It refers primarily to the payment of 2,673 employees in EHD Urumqi, (Fridley, et al., 2008) and other hundreds of employees of MEP and environmental research and supervisory institutions. It makes up roughly the eighth part of the annual budget.

The cost calculation in single segments within the ranges of MSWM enable us to trace the total cost C_{msw}, understand as the total expense on managing MSW per unit. Administrative cost is out of the calculation as the cost for human resource has been already included in C_c and C_t. In addition, an extra cost of tax and commission fee C_{ta} of 10 Yuan/t has been added as transaction cost. (Yao, Fulong etc.; 2009, 25) While the cost calculation in Urumqi looks like as follow,

$$\begin{aligned} C_{msw} &= C_c + C_t + C_{tr} + C_{ta} \\ &= 55 + 40 + 60 + 10 \\ &= 165 \text{ Yuan/ton} \end{aligned}$$

According to this cost calculation, suppose that all MSW in 2006 were collected and discharged in sanitary landfill, the cost would be at least 250 million Yuan, which is much higher than the budget for the MSWM in the same year. Thus, the current existing charging system is obviously not capable to finance or support 100% MSW sanitary disposal.

The analysis of the costs and expenses of MSWM gives us a comprehensive financial overview of the process, and builds up the pattern for more potent arguments for pricing and modeling in developing a practicable and cost-effective charging system that suit Urumqi' living environment. Meanwhile, in order to deal with the problems subsequent increasing quantity of MSW, relying on government financial appropriation is not going to take the matter forward anymore. It needs for more complementary measures such as market-oriented strategies or alternative means of charging while building in appropriate incentives to encourage efficiency in material flow.

4.3.2 PAYT Pricing Program

MSW generation causes external cost and reduces the social welfare, leading to economic inefficiency. (Porter, 2002 pp. 6-7) Therefore, it should be internalized through sophisticated economic lever such as adept tipping fee. Consequently, there

is incentive to develop models to help policy makers choose the efficient mix of policy levers, that feasible to regulate MSW related activities.

In most countries including China, MSWM has been regarded as one of the government functions. According to prevailing principles in terms of waste treatment, polluters are responsible to pay for the MSWM service that provided by the public factors. Thus, it would be necessary to examine alternative means of charging to improve allocative efficiency. Basically there are worldwide two prevailing waste charging platform, “fixed charge” (FC) and “Pay-as-you-throw” (PAYT). FC is prevalently processed in many cities in China, in name of tipping fee or hygiene fee. In some areas, it’s been implicitly included in the utility bills.

According to the FC, the households or enterprises pay the tipping fee monthly or yearly by a uniform rate. The advantage of FC is its’ simplicity in pricing, as the policy makers have only to learn the total cost of MSWM service as well as the number of households. Generally, FC is easy to adopt in order to build up necessary funds for waste treatment, and helping government to release financial pressure. On the other hand, the disadvantage of FC is also obvious. The unified price or collection rate that extended on all households (regardless of how much garbage has been dumped), which is not only unfair, but also causes inefficiencies in at least two ways: firstly, as the households do not have to worry about an overcharge for “too many” dumped waste, they wouldn’t have the motivation to reduce the quantity of waste generation; secondly, it has led to a lack of enthusiasm for producers to promote environmental friendly products, in order to reduce the potential MSW like packaging etc. (Dinan, 1993 pp. 244-245)

In addition to the mentioned disadvantages of FC, there are also other problems occurred in practice such as low collection rate associated with high collection costs. The true collection rate in practice is only 30% to 70% according to different areas. And the collection costs are reaching 20% to 50% of total collected amount, which is caused by overstaffed bureau and non-transparent procedure. (Chen, et al., 2005 p. 29) The loss could be clearly identified through a comparison between the collection of tipping fee and water consumption fee. For example in Urumqi, the collected amount of tipping fee in 2000 was 2.89 million Yuan, which was only equal to 1.4 Yuan/y pro person. However, in the same year, 24.8 million Yuan has been collected

as water consumption fee, more than 10 times of collected tipping fee. Existence of widespread non- compliance is apparent by tipping fee collection.

In terms of PAYT, the level or amount of tipping fee determined by dumped quantity of MSW. Comparing with FC, PAYT could encourage consumer to reduce MSW generation by adjusting their consume behavior, such as recycling or choosing products which generate fewer MSW. For pricing and designing of PAYT programs it may cost more cash and time than FC programs, prerequisites and baseline data are also required. However, it's good at dealing with shortcomings of FC in accordance with the PPP principle. A majority query on PAYT comes from the concerns of "illegal dumping" problem. However, many studies have shown that actually "it is big fear than reality". (Skumatz, et al., 2006 p. 14)

In 2007, Urumqi's government promoted "Urumqi Multiple Solid Waste Fee with Water Fee Bundled Collection Program", aiming at levying tipping fee in correlation with existing water supply charging system by adopting water consumption coefficient as a proxy variable. This is a helpful attempt in proceeding of PAYT. According to the new charging program, water provider would be commissioned as charge agency an behalf of MEP to collect tipping fee with water fee together with respects of fixed unit charging rate that instructed by MEP: households have to pay 1 Yuan tipping fee for using of one m^3 domestic water. Water consumption used for business service or other special purpose is associated with 0.8 Yuan/m^3 tipping fee. (Yao, et al., 2009 p. 141) The collected amount of tipping fee could only be spent on the waste management practices

The new program adopting water consumption as related proxy variable is actually a practicable measurement in terms of PAYT. The decision maker calculates the required cost of MSWM service according to the quantity of MSW generation, and then confirms the suitable coefficient to water consumption. The water supply platform in China has been developed over the past decades. In 2004, there were 509,600 households having water supply, in which the number of family users were of 433,160. (Fridley, et al., 2008) Most of inhabitants in urban area have been covered. It has been provided a good platform for the new MSW charging program.

In addition, according to the relating approach that has been investigated among households in Urumqi, there is a very close relationship between the amount of dumped MSW and water consumption. In a simple regression analysis model, it's showing a strong positive relation with a correlation coefficient of r = 0.7894. (Yao, et al., 2009 p. 439)

Drawing reference from experience of Shenzhen, where the similar PAYT program has been already adopted since years, total collected tipping fee as well as collection rate have substantially increased, reached 433 million Yuan/y and 93% respectively in 2007.[5] The similar performance could also be expected to happen in Urumqi. However, it doesn't mean that such a program is running without problems. For example, there are only two categories adopted in modeling of the program, which could probably not fully cover the complexity of various social unites. Variation of MSW generation needs to be examined, in particular for business sectors with disproportionately small or large quantity of waste generation in relation to the proposed proxy variable. For instance, the super markets or curbsides markets produce huge amount of MSW but with few water consumption. In further, it is necessary to adopt different coefficient rates for more social unites.

[5] Kunming Daily, 13.10.2008

5 Municipal Solid Waste Management Practices and Service in Urumqi

Municipal solid waste management practices and service includes MSW collection, transport, disposal and further treatments of MSW. The households rely on garbage collection by the government. The local Environmental health administrative department is the major agency in charge of performing MSWM practices. A large proportion of collected MSW are disposed only in the simple landfill disposal sites without or with primary environmental protection measures. Many simple landfills have been overloaded over years, and the new landfills that during construction or will be constructed will not be capable to dispose all MSW safely either, as the quantity of MSW generation increased too fast. In addition, waste pickers and collectors participate in the MSWM as informal factors, making essential contributions to waste collection and recycling.

5.1 Collection & Transport

5.1.1 MSW Collection

There are at least 100 million tons of MSW every year need to be collected or cleared in Urumqi, majority of which have been done by the public agency “Environmental Health Administrative Departments”. Despite some of tradable products that have been collected by households themselves to sell at a profit, MSW are generally mixed collected in Urumqi, as the rest waste comprises both organic and non-organic material.

MSW containers located in residential communities or on the curbside of streets provide more evidences that MSW are majority mixed collected. The MSW container that I am showing in the graph below is typical in a common residential

community in Urumqi. The estimated volume ranges from 5 m3 to 20 m3. If there are more containers located in the same community, it doesn't mean a separate collection but just other one. The container would be cleared or replaced by an empty one when they are filled up. Generally, the collection behaviors don't happen in fixed time. According to the relating regulations, it should be cleared before the dumped wastes are 20 – 30 cm beyond the surface of container. The collection work has been usually implemented by hand. In many suburban areas or in small streets, MSW could also be dumped directly in the open air when citizens litter indiscriminately and collection services are inadequate.

Figure 6. MSW Container in a residential community in Urumqi

EHD is also responsible for cleaning up public areas and related activities such as setting garbage bins in public areas. For example, in 2007, there were 8,000 new garbage bins have been placed in shopping malls, curbsides of main traffic or bus stations, with an intervals vary from 20 meters to 100 meters. Those garbage bins are generally divided into two separate tubes tagged for "recyclable waste" and "non-recyclable waste". However, very few people know exactly the differences between two categories due to the inexplicit instructions. As a result, the wastes are arbitrarily dumped in any one of two trash barrels, and the MSW in public areas are in fact mixed collected as well.

5.1.2 MSW Transport

According to different collection objects, garbage transport trucks can be divided into MSW trucks, kitchen residuals trucks and other type of garbage trucks. According to transport functions it can be divided into garbage collection trucks and transfer garbage trucks. (Between garbage transfer stations) The garbage collection trucks include garbage dump trucks, self-loading garbage and compressed garbage trucks etc. (Xie, 2002 pp. 44-45)

Up to 2006, Urumqi had in total 301 all kinds of garbage trucks running for MSW collection and transport. However, in fact, not all the MSW collection works are completed by those trucks. There are also human-powered plate tread wheels or other motor-powered plate tread wheels used by staffs of EHD to collect MSW, especially in narrow lanes or residential communities which are not close to the main street.

Type of Garbage Trucks	Garbage Dump Trucks (GDT)	Multi-Function Garbage Trucks (MFGT)	Enclosed Garbage Trucks (EGT)	Compressed Garbage Trucks (CGT)	Medical Garbage Trucks (MGT)	Total
Amount	88	62	20	126	5	301

Table 10. Type of Garbage Trucks in Urumqi
Resource: (Annual Report Urumqi , 2007 p. 115)

GDT and MFGT are those kinds of garbage trucks without enclosed container. Basically, these trucks operate without any mechanical automation for garbage loading. The garbage is transported under a direct contact with open air, or it would be only covered by simple canvas which is quite common in many middle or small cities in China. Thus MSW transport without enclosed trucks is associated with a potential risk of secondary pollution.

In recent years, more and more non-enclosed garbage trucks have been replaced by garbage trucks with enclosed container. In Urumqi, roughly 50% of all garbage

trucks are EGT or CGT belonging to enclosed garbage trucks. However, almost all of the enclosed garbage trucks are operating in the four central districts of Urumqi. These trucks are constructed in accordance with relating national environmental protection regulations and are able to prevent many practical problems during the transport like garbage scattering. Some types of trucks could also work with existing garbage containers or garbage dumps compatibly. As long as the old trucks are becoming obsolescent, more enclosed garbage trucks will be put into service in further.

However, it is not saying that there are no problems by using existing EGT and CGT. Firstly, MSW in China content more moisture substances, so that leachate could be easily generated by precipitation percolating through a compress process during transport, especially by CGT, which would compress the MSW immediately as soon as they are loaded. Thus how to prevent leachate generation or at least to collect it in order to prevent further pollution caused by other subsequent toxic materials is still a concerning issue by MSW transport.

Secondly, lacking of observation system to sensor the loading process and loading condition of trucks causes not only an inefficiency in garbage loading, but also raises the risk of accident in operating.

The last but not the least, garbage trucks that will be put into operation in further must be capable to work with the garbage containers together, which are settled or will be settled in the residential communities. However, there is no such a unified plan in process to specify the issue, neither in Urumqi nor in China.

MSW that collected by garbage trucks or plate tread wheels are usually not transported directly to landfill disposal sites but will be stored at first in the garbage transfer stations (GTS) temporally, where the garbage would be primarily selected and handled.

There are 23 GTS scattered all over Urumqi by 2006. Eighteen of which are belonging to mobile GTS —two or more containers with compress function and leachate collection structure carried by trucks. Non-mobile GTS is always used to discharge collected MSW for short time. Garbage will be weighed up, compressed, and the recyclable components would be roughly selected as well. Bulky garbage

could also be disassembled or broken up if there are equipments available. The compressed garbage needs only fewer rooms in further transportation until reaching the landfill sites.

5.2 MSW Discharge

MSW disposal refer to activities proceeded during MSWM, in order to reduce the quantity and volume of solid waste, to eliminate or modify the risk of other hazardous component of solid waste, by adopting incineration, composting or other activities to change the solid waste regarding it's physical, chemical or biological characteristics, or disposing the solid waste in landfill in accordance with environmental guidelines.[6] According to this national official declaration, the disposal of MSW includes three major operative processes: disposal by landfilling, incineration and composting. In addition, it also includes other physical operations like compressing and disassembling.

5.2.1 MSW Discharge in Urumqi

At present there are no operative facilities available for mass disposal of MSW by incineration or composting in Urumqi. Generally, which process for MSW disposal should be chosen depends upon the following three considerable factors. First of all, regarding major composition of MSW, inorganic-based solid wastes are suitable for landfilling, as this kind of waste contents higher ash specification with relative stable chemical components. Disposal of inorganic-based MSW by landfilling causes fewer soil and groundwater pollution as well. Besides, due to the poor combustion performance and low calorific value it is also not suitable for incineration. In the former chapter we have learned that the composition of MSW in Urumqi includes a relative low proportion of kitchen residuals which are mainly consist of organic matter, but contains a high percentage of construction waste as well as other non-organic types of wastes. This is the first reason that disposal by landfilling may be a better choic than by incineration or composting in Urumqi.

[6] Environmental Protection Law of the People's Republic of China, Article 74

Secondly, economic development and technique innovation also limit the range of choices. From an economic point of view, MSW incineration requires the most investment and operation costs, composting takes the second place and landfilling costs the fewest in three processes. In addition, it turns out another rank but with the same order if we compare the technique prerequisites for three processes. Actually not only in Urumqi, landfilling is the overall dominant operative disposal process of MSW in other urban area in China as well, as this process needs relative low costs for implementation. (Wang, et al., 2007 p. 218) As a dual solution to the solid waste and energy crises, incineration requires high operation cost and sophisticated application, which is usually implemented in industrial lands or in regions where land is scare. (Kinnaman, et al., 2000 pp. 105-106) Urumqi is neither economically nor technically qualified for implementing incineration.

Last but not least, the demand on by products of MSW disposal also determines which process should be adopted. For example, if the composting could be recommended as the feasible program depends on the market for compost products. Adopting MSW disposal process by composting or incineration for energy generation might also be a cleaner solution. However, due to the competitive disadvantage of price, comparing with other energy resources which are much cheaper, these processes are really hard to proceed in practice. Consequently, landfilling is overwhelming in Urumqi.

5.2.2 MSW Discharge by Landfilling in China

Landfilling due to its' economic advantage becomes overwhelming MSW treatment solution in many developing countries, so it is in China. According to "Technological Policy for Treatment of Municipal Solid Wastes and Its Pollution Control", which was released jointly by MOHURD, MEP and CAS in 2005, at present "in cities with available land resources and suitable natural conditions for sanitary landfills, disposal in sanitary landfill sites should be a prior consideration for MSW disposal solution."[7] In essence, more than 85% of MSW are disposed by landfilling in China. (Wang, et al., 2007 p. 12) Few landfills are operated for profit as commercial businesses. Many landfills, however, are publicly operated and funded.

[7] Artical 1.6, 2000

Landfill plants in China can be basically divided into three groups according to adopted environmental measures. Modern landfill plants developed from waste dumping in certain place in open air. This disposal technique has barely changed from the beginning of human settlement into organized communities. In China, the "dumping sites" which were constructed in early 1990s are landfills with no environmental protective facilities. The wastes that have been transported to these sites are either simply buried out or dumped directly in the open air. There is still more than 50% of landfill plants up to today are "dumping sites" in China. To construct "dumping sites" needs quite few investments and almost no technique prerequisites. However, the subsequent environment impacts or gas-related problems caused by biological, thermal or other processes among waste material are extreme. Most of these impacts to surrounding environment are inevitable and could last in the long term.

	Dumping Site	Simple Landfill Plant	Sanitary Landfill Plant
Construction Period	1990-1995	1995-2000	2000-
Characteristics	Few protective facilities, totally disregard environmental standards	With protective facilities but don't match the environmental standards	With robust protective facilities, qualification of environmental standards
Environmental Impacts	Serious pollution	Certain influence on environment	Few pollution
Proportion	50%	30%	20%

Table 11. Categories of Disposal Landfill Sites in China
Source: (Wang, et al., 2007 p. 219)

Since mid-1990s, as the result of codification booms for environmental laws and regulations, China began to build more “simple landfill plants” which equipped more facilities against pollution caused by waste dumping to minimize the environmental impacts. However, due to the poor regulatory and weak investment, waste dumped in “simple landfill plants” has not been safely assimilated into the surrounding environment. Thus the escape of waste materials and degradation is still inevitable. They have been caused series of environmental problems like contamination of groundwater or residual soil contamination.

The modern “sanitary landfill plants” that began to construct in recent years, are operated with environmental protective controls and management according to the national environmental standards and specifications. This kind of plants account approximately for 20% in all operating disposal landfills, but the proportion will be surly increased as long as more old plants would be enclosed in further.

5.2.3 Landfills and Other MSW Treatment Plants in Urumqi

Up to 2003, there were three large landfill plants in Urumqi, “Xishan”, “Dongshan” and “Donggebi” landfill plants, which were named according to their locations “west hill”, “east hill” and “east Gobi desert”. These landfills are basically belonged to mixed plants of “dumping sites” and “simple landfill plants”. The collected MSW were mainly dumped into barren gutters among the mountains, without any protective treatments but were only covered with soils, produced a lot of pollutants into land, air and water, and posed subsequent risks to human health and the environment. In Xishan Landfill, for example, a huge “waste mountain” over fifty-meter-high, has been piled since the landfill was constructed in 1879; the other large landfill plant “Dongshan” which located near the source of “Shuimo River”, caused a serious pollution in the river because of leakage.

Since the millennium, as the old plants could not meet the environmental requirements anymore, and most of them have also been overloaded due to quick increasing of MSW generation, construction of new landfill plants has been schemed on the agenda. “Xishan-Dapugou” sanitary landfill plant was started to construct in April 2000, which was already completed until the end of August 2002 and in July 2003 formally putted into operation. It is the biggest landfill plant in western China,

with total volume of 30 million m^3, processing capacity of 2000t/d. It is also the only one sanitary landfill plant in Urumqi at present, which is expected to operate in the next 30 years.

The new plant also equipped a specific incinerator to burn hazardous medical waste, which is able to handle maximal 15 ton medical waste per day. Incinerator ash is toxic and must be disposed in an expensive toxic waste landfill which is also provided. Acoording to the environmental impact report of the project, the adopted processes to control leachate, toxic emissions and noise are also implemented under national environmental standards.[8] In further, more traditional landfill sites will be replaced by sanitary landfill plants.

In addition, a "Food Waste Comprehensive Treatment Center" has been constructed and putted into service since 2005 to treat and compost the kitchen residuals in urban area. Besides, Urumqi has planned to build a new hazardous wastes disposal plant in west outside of the city as well, based on the existing "radioactive waste repository". The new plant should include specific disposal landfill and incinerators to disposal and eliminate the hazardous wastes safely. Currently, because of technical difficulties, the program remains still in the process of proof and arrangement.

5.3 Participation of Informal Factors in MSWM

When we are talking about informal factors in the MSWM is usually referring to those people who pick, collect and trade waste privately, who are correspondingly called as waste picker or waste collector etc. In some literature devoted to the issue, waste picker has been differed to waste collector, as "one group of them is called pickers who just pick up waste thrown away in public places such as streets and parks", and "another group is called collectors who go around households, shops and restaurants to buy waste". (Hayami, et al., 2006 p. 42) According to this definition of "pickers", they are more likely as scavengers. However, they are in essence not equal

[8] Environmental Impact Report for Construction of Xishan-Dapugou Sanitary Landfill Plants in Urumqi, Xinjiang Research Academy of Environmental Protection Sciences (AEPS)

to scavengers, as a scavenger, at least in Urumqi, may live on waste picking but not working on it. In my approach in this subchapter, the contribution of informal factors to the MSWM, and the issues that relating to those contributions will be discussed. Therefore, I will use “waste pickers and collectors” (WPC) to definite the involved members of informal factor.

Whenever you hang around in Urumqi, on any street located in center of the city or in urban-rural area, it doesn’t matter if you are in aged one-stored house areas or in new constructed resident communities, you could always find those people, who are pulling or riding on the plate tread wheels, searching for or transporting valuable waste for profit. These people are who we mentioned as WPC. Today, there are more and more WPC, not only in Urumqi, but also in every city in China, working on waste collection and recycling.

How many WPC are there actually in Urumqi? It’s really hard to get the exact figures due to their high mobility. According to a survey that processed by Beijing Academy of Social Sciences, there were about 82 thousands WPC in Beijing by 1998, while just after two years in 2000 the number increased to 100 thousand. It’s been estimated to be 300 thousand, around 2% of total population now. (Jin, et al., 2006 p. 340) According to this rate, we could estimate that there are roughly 50 thousands MPC in Urumqi. A vast majority of these MPC are immigrants from neighboring area of Xinjiang and also from far off counties. Generally there is no reason to limit the locations where they are coming from; however, it is always easy to find businesses in the branch if a lot of people are coming from same hometown.

WPC actually interact with a larger group than is commonly seen. As a great number of people have been working on the issue for a long time, it’s indeed already formed a business with several trading chains between WPC groups. Single or non-organized WPC are usually waiting in the residential communities or hanging around from bins to bins on the street to collect the open dumps or the waste that littered on the street. Some organized WPC are allowed to enter GTS or landfill sites which is usually associated with an entrance fee. Digging on the garbage hills is illegal; however, it’s quite common in the practice. The members of the group who pick and collect recyclable materials from mixed waste in the landfill sites are usually not “stockholders” to each other, but more likely hired by the organizer who paid the

entrance fee. This organizer is also one of WPC leading his instable team. Besides, WPC also purchase waste from house to house. The items on their purchasing list could be any profitable waste materials, such as paper, PET bottles, metal cans etc. The profits come from the price differences between the purchasing price and the sale price to the public recycle station (PRS). Collected waste could also be sold to waste dealers, who located usually only in urban-rural area to avoid the municipal administrative enforcement. The waste dealers have connections to producers who need the recycled materials for further reproduction.

Today many common inhabitants in Urumqi know that the wastes are valuable. But WPC know more about MSW at profit. This is the most important reason that a large scale of WPC emerged in recent years. Besides, the oversized population that caused by urbanization creates a huge surplus on the labor pool, with a decreasing resource base could those unemployed immigrants or native hardly to find a “dignified” job in city. Meanwhile, incompetence of public sectors in MSW collecting and treating giving them an opportunity to participate in the produces, as an informal or adjutant factor to relieve the pressures caused by increasing MSW.

WPC cover every corner of city and keep the streets and city sanitary. They facilitate urban residents by hardworking, taking the work that no one in city would like to do to keep the opportunities to live in city. For WPC the city life is not only associated with more business possibilities, but it also means a higher living condition for themselves and younger generations to access “higher life expectancy and literacy rate”, (Satterthwaite, et al., 2009 p. 17) to pursuit a better life, at least seemingly to them. However, their activities are also accompanied by various problems for society, and for themselves. Lacking of technical and instrumental specificities during MSW collection and transport cause the risk of re-contamination and also threaten their own healthy. Trading of waste is profitable but most of WPC scratch gravel from morning till nigh to provide the family merely. As long as more people join the troop of WPC, the competition has been grown sustainably, so that their already limited living space is getting smaller and harder. In fact, WPC are facing the direct access to the environmental hazards that resulted by the urban vulnerabilities. They are struggling to have a dignified life with doing a job without dignity, they have been escaped from abject poverty with their efforts but just moved to poverty with dignity,

nevertheless they could do nothing to control their own further. “They are mostly very poor, face social and economic exploitation and have little say in the formulation of policies that directly affect them.” (Choudhary, 2003 p. 5240)

5.4 Material Flows for MSW in Urumqi

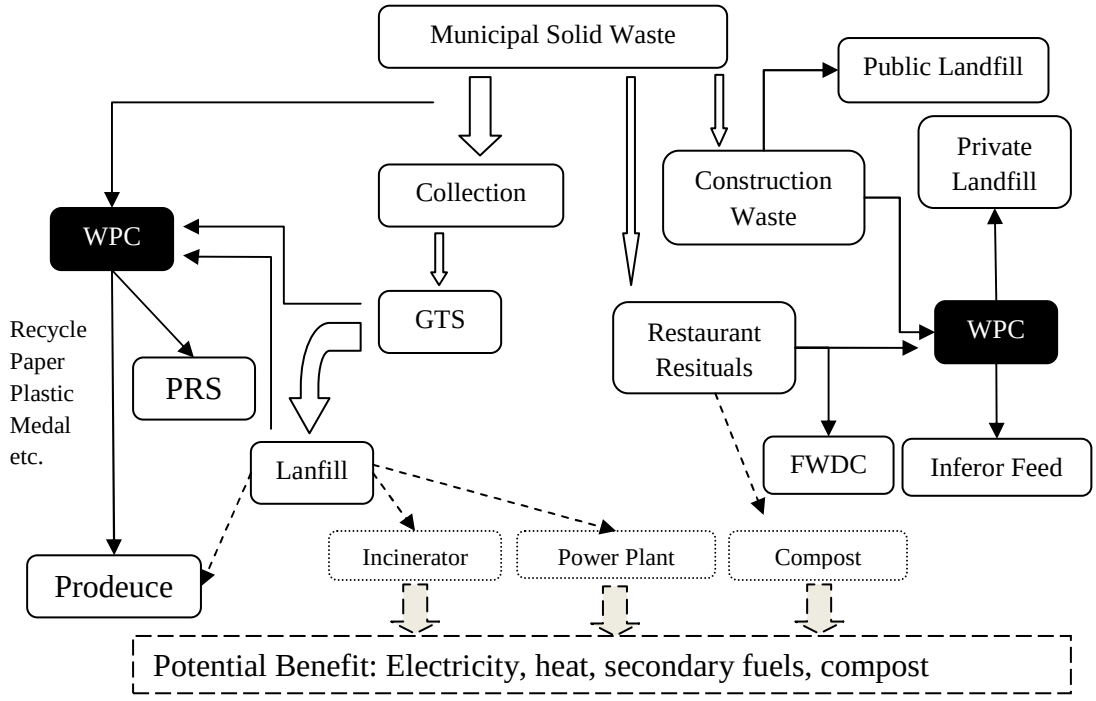


Figure 7. Diagram of Modeled Material Flows for MSW in Urumqi, own design

At present, the major MSW disposal is still by landfilling. It is essentially a passive operation against MSW generation, which occupies a lot of land area, causes negative environmental impacts and limits the further use of polluted land and water. Most of landfill disposal plants are operated by public sectors making no profits at all, so that the local government is facing greater financial pressures by MSW disposal. More laws released in recent years imposed technology-based standards on the construction, operation, and closure of solid waste landfills leading to further cost increase. More important, as a result of rapid increased MSW generation, many cities

are running out of landfill space. For example, “one third of China's 660 big and medium-sized cities are surrounded by dumping garbage, according to the Ministry of Construction[9] By landfilling in suburban area, so that in many cities, it’s getting harder to find suitable space for construction of new landfill plants.

Incineration, once considered a dual solution to the solid waste and energy crises, has become a more viable option. However, they are barely operated in China due to high demands on investment and technique. With adequate technical practicability MSW incineration plants would be an adept solution as a complement of landfilling. It converts MSW into ashes, flue gases, particulates and heat, which can be used as secondary fuels for electricity generation or heating. With a control of exhaust fumes, this process can be a good substitute for coal burning, to improve the air pollution in Urumqi.

In addition, recycle is the core idea to reduce the quantity of MSW generation and to promote the circular economy. However, households may not be the best slit to performance separate collection at present, as the local inhabitants has been accustomed to the current dumping behavior for a long time. Unless incorporating people’s beliefs and values into adequate behaviors, to drive people’s choices on consuming and recycling, any action will not be sustainable. Besides, reduction of the large group of WPC is also not realistic currently, and they are still indispensible in MSW collection and recycling. In further, it is necessary to examine alternative means of management, building regulatory market in appropriate incentives to encourage more private factors enter the MSW market.

[9] China Daily, online available via http://www.chinadaily.com.cn/china/2009-03/10/content_7557859.htm

6 A Questionnaire Survey in Midong

6.1 The background of the survey

China has been enjoyed a rapid economic expansion in recent thirty years, which is broadly expected to continue in foreseeable further. However, the economic success in the past could not ensure that the same scenario will repeat smoothly in the long term unless adopting sustainable environment and economic development strategies in both political and economic realms in order to promote further development sustainably. The initial engine of China's high-speed economic growth was from the large number of low-cost labor supply as well as huge energy and resources consumption. Low level of capital costs enabled China to locate itself in the position of "world's factory", and to complete national industrialization in a very short time as well. However, similar to what happened by other industrial countries in their industrialization processes, a series of social and environmental problems emerged, — somehow ineluctably, as consequences of unrestrained economic expansions. Those problems have been covered or selective neglected by the public or by the government, as the whole society slipped into such a joyous atmosphere towards the rapid growth of GDP. In pursuit of high profitable outcomes, no one is really interested in concerning of the environmental degradation and other social problems emerging during radical economic transition and social changes, as long as the problem have not yet splatter all over the ground.

However, things began to change when China's government realized that the low-cost labor pool is gradually dwindling and public also began to oppose the exposing to environmental threatens, such as extreme events and health risks to citizens. Moreover, high level of dependent of economic growth on energy and natural resources consumption causes extreme deterioration on environmental condition, which not only declined the living level of people, but also restricted the further potential development possibilities. Thus, in order to provide a legal framework for sustainable economic development, "Recycling Economy Promoting Law of the

People's Republic of China" has been passed at the end of 2007, aiming to promote economic sustainably.

According to this new legislation to promote "recycling economy" or the "circular economy" in China, the driving forces of the economy should be reloaded. Instead of excessive and wanton depletion of human and nature resources creating and developing a new dynamical economic development pattern, which requires low energy consumption, high efficiency of resources utilization and causes few influences on environment.

The legislation requires all involved economic sectors to adopt 3-R principles in their activities, especially in productive processes, with corresponding technical availabilities and management tools, aiming at promoting higher efficiency in resource using. The 3-R principles refer to reduce, reuse and recycle the energy, natural resources, emissions of pollutants and industrial or municipal solid waste, which have been consumed as output factors or produced as byproducts in productive operations or in consumption behaviors, for the purpose of building a circular material flow inside the whole economic and social realm, adopting a sustainable development strategy in the long term.

However, in recent years, subsequent governmental strategies for sustainable development placed more and more emphasizes on active engagement by all citizens in the environmental debate, which is in contrast or parallel to traditional top-down policy making approach, as "sustainable development cannot be imposed from above. It will not take root unless people across the country are actively engaged." (Barr, 2003 p. 227) Therefore, the project RECAST is also following such a national development interest, trying to meet an all-round approach promoting an efficient resource consuming megacity development in Urumqi, engaging in strategies for promoting environmentally responsible behaviors, such as energy saving, water conservation and waste recycling by three different task groups within the RECAST. In its first year of a five-year mission, aiming at collecting comprehensive data in study area, — Midong, household members have been interviewed by using designed questionnaires, in order to draw the overview of behavior on MSW collection and dumping, as well as use of energy and water in the area.

6.2 Midong — A new District in Urumqi

Midong district was officially established in 2007, located in northern part of Urumqi. Distance downtown Urumqi makes an appointment with only 15 kilometers. It covers a total area of 9,970 m^2, with a population approximately of 295.5 thousands, and about 31.03% among which are non-Chinese ethnic minorities. As the planned further sub-municipal center, its' GDP reached 9.64 billion Yuan by 2007. (Annual Report Urumqi, 2008 p. 39)

The new district is actually an integration of two parts, — the former Miquan city, which was administratively belong to Changji Hui Autonomous Prefecture, and Dongshan district, — an old division of Urumqi. The establishment of Midong district was on purpose to promote the national development strategy in the region, which is so-called "Urumqi-Changji Integration". Changji here refers to the capital city of Changji Hui Autonomous Prefecture located 35 kilometers away from central Urumqi. It has about 350 000 residents, adjacent to both Urumqi and former Miquan city. In order to press ahead this regional integration program, Changji Hui Autonomous Prefecture contributed a city Miquan, combined with a district from Urumqi together to promote the economic cooperation between Changji and Urumqi. The new established district Midong administratively belongs to Urumqi.

Midong is supposed to be the industrial hub of Urumqi and Xinjiang, driving development in the next rung under Urumqi-Changji Integration. It has at present three provincial level industrial parks, dominated by petrochemical and coal chemical industry, construction material industry as well as modern manufacture. Huge investment of industrial materials in Midong has been and will unfortunately cause inevitable deterioration on the environment. To reduce or minimize the negative effects – especially in such an environmental vulnerable region, it is more necessary adopting efficient material flow in Urumqi than in other regions. We choose Midong, — a division processing its' radical economic transition and social changes, as a representative district for Urumqi, because of its overall closeing characters to Urumqi, and its potential large scale processing of regional natural resource as well as the subsequent production steps.

6.3 Objective of Questionnaire Survey Research

The primary goal of this questionnaire survey carried out in Midong aims at absorbing reliable data of individual behaviors of household in using energy, water, and in generating waste, to validate residents' environmental behavior, including their attitudes and actions towards general environmental issues, which would be combined with other series of surveys on industrial sectors together, building up the cornerstones for further studies, enable to adopt specific solutions to problems in further urban and economic development, such as inefficiency in marital flows as well as subsequent impacts on environment, making realistic predictions or responsible decisions.

For a long time governments have attempted to deal with environmental problems by arguing that technical progress will eliminate the environmental impacts that caused by industrial and productive activities of human being. Yet, environmental degradation is now getting worse at a far faster rate than technological advances can hope to keep pace with. As a result, adjustment of human behaviors might be an important part of environmental improvement in further.

With the goal of describing and analyzing the status quo of MSWM, we are trying to get the comprehensive scenario in a wide range, which could present local residents' awareness, attitudes, behaviors and concerns towards MSWM in Midong all around, especially the factors important to segregate collection of MSW in households, so as to find manageable processing of waste. It will also be combined with the reorganizations over energy and water consumption, as a reasonable consideration regarding their energetic and material inter-transformation, to create an integrated approach for efficient, economic and also manageable developing strategy for Midong as well as Urumqi region.

6.4 Interview and Interviewer

The experiences and practices of MSW of people in Midong are documented. The data were gathered through face-to-face interviews that conducted with households' members by using a designed questionnaire. It was surveyed by IUWA, Xinjiang Research Academy of Environmental Protection Sciences (AEPS) and Urumqi Solid Waste Management Center (SWMC) jointly. As a local social public welfare scientific research organ, AEPS engages in environmental basic science and applied science. SWMC subordinates to MEP Xinjiang engaging in all MSWM related issues in Urumqi. Both Chinese institutes were on behalf of the MEP Xinjiang to cooperate with IUWA devoting to the investigation. From this point of view, it is a joint investigation implemented by Chinese government (MEP) and German scientific institute (IUWA).

There were totally nine interviewers were qualified from taking part of program to carry out the face to face investigation in households in Midong, among which seven interviewers were from AEPS, and rest two came from SWMC. Eight of nine interviewers engaged in interviewing each day, and were divided into four groups to keep two interviewers in a team at any time. It's been proved in the previous test interviews that with such teamwork overran time of each interview could be reduced efficiently. More important, we provided, at least a kind of, supervising system to avoid arbitrary filling up or wrong statements in transcription by allocating different duties to interviewers and keeping them to watch out each other.

All interviews took place from 28th November to 3rd December, 2008. Interviewers worked each day from 10 a.m. until 8 p.m., so that the people on job would also be involved. The questionnaire was originally designed by IUWA in Germany, and a revision has been adopted by joint working group including MEP to fit the Chinese ordinary inhabitants understanding and special situation in China. Thus, we ran a two days training for interviewers helping them to attain appropriate understanding of questionnaire and to learn necessary prerequisites as a qualified interviewer. As the questionnaires were principally only allowed to be filled up by interviewer and would not be necessary hand over to interviewee, so that they were independent of

respondents' complete control. Consequently, a strong interview skill is a must, and the interviewers needed a strong understanding on the purpose and principles behind the letters, so that they would not describe the questions in a wrong way, and would also be able to help interviewees with misunderstandings into rehab and to get them straightened out immediately. Besides, two researchers from IUWA have been taken part in the operation as observers and trainers in the training program. However, due to local lows and regulations, two researchers were unfortunately not allowed to enter the households.

6.5 Introduction of Residential Communities

Community	Location	Number of Residents	Features
C1	Dibang Street	11000 residents	Miner families, former Dongshan Districft
C2	West Gumudi Street	3277 families; 9833 residents.	Modern Community with new Biudings
C3	West Gumudi Street	200 families	Old and open-plan Community
C4	Daoxiangzhong Street	528 families; 1820 residents.	"Village inside City"
C5	Kaziwan Street	n.n.	Local staff and Workers
C6	Minzhu Street	n.n.	One-Story Houses area

Table 12. State of Six Communities, (AEPS, 2009 pp. 4-6)

The central part of Midong is planned, — as it's illustrated in the graph below, with a separate arrangement of residential areas which are located in the middle-east of the city, and industrial areas which lie on the west part of the city. There is a railway passing through industrial areas and an expressway lying besides residential area connecting Midong with centre Urumqi.

Six representative residential communities have been chosen in downtown Midong building up the whole study areas, which have been labeled and plotted from C1 to C6 for community one to community six in the graph to get a better overview of their location distribution.

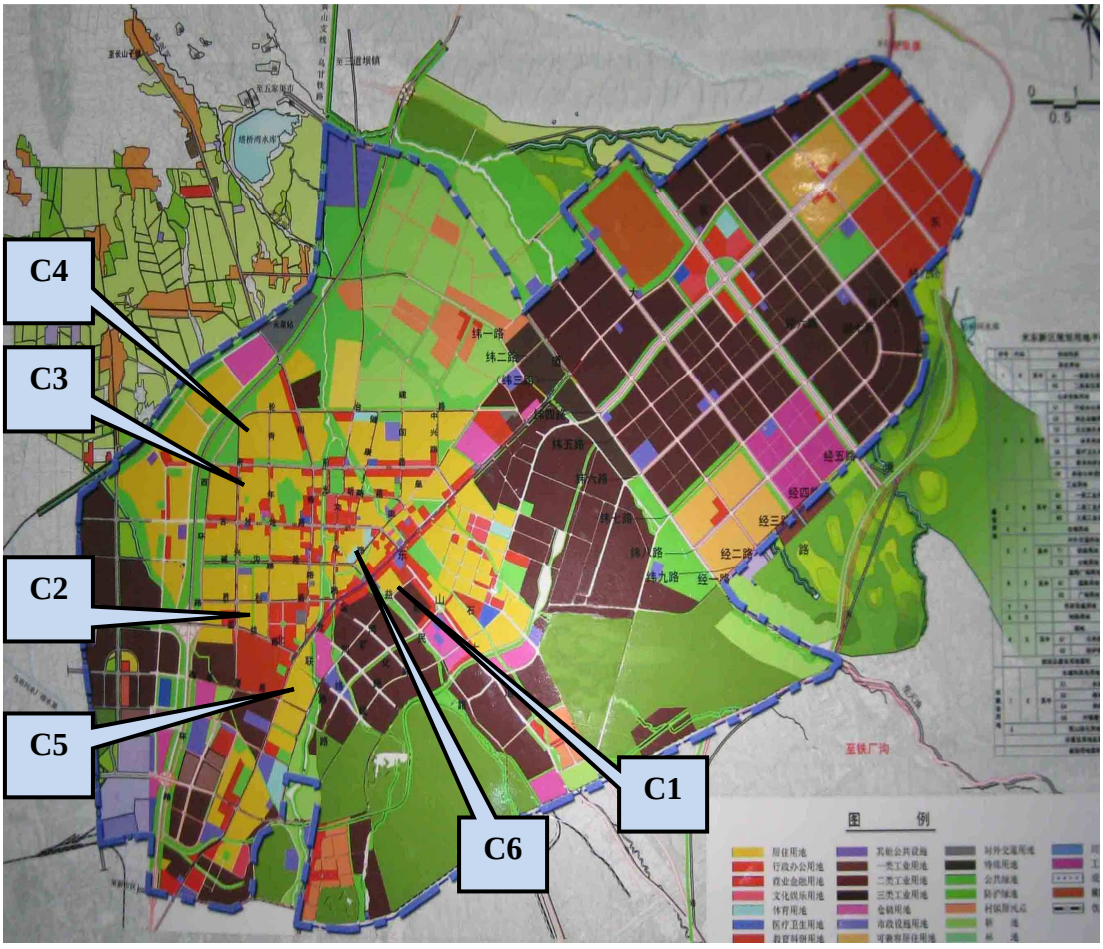


Figure 8. City Planning Midong, own design

Each of six communities has its individual characteristics with respect of different living groups or condition. There are a lot of living communities in Midong built for

local staffs and workers like C1 and C5. C1 has the largest number of residents in all six samples consisting of coal miner workers and their family members. It is located next to a mining area within former Dongshan District. C2 is a newly constructed community with best housing and environmental condition, as it has more modern buildings than any other community has. C3 is an old community with many rundown buildings. This community is opening direct to the street without community property management. C6 belongs to one of the traditional one-storage housing area with residents who are major coming from low-income or disadvantage groups. C4 is a so-called “Inside-City Village”, which is prevailing in the urbanization process of cities in China. Generally, these areas are originally belonged to rural fields, but have been integrated into the city as a result of urban expansion. However, for some reason the original residents were not relocated. This community consist 20% more-storage buildings and 80 percent one/storage houses. (AEPS, 2009 p. 5)

6.6 Design of Questionnaire

6.6.1 Research Method

Before the steps of the process unfold, we should clarify bunch of knowledge claims like what we will learn and how we will learn with our inquiry. The study is descriptive in nature, using questionnaire and structured interviews for data collection, with the intent of generalizing from a sample to a population. Besides gathering statistic data, it also includes prevailing attitudes towards environmental concerns of households’ members, with which we are able to get approaches of inhabitants’ awareness and picture their behaviors in terms of environmental condition and vulnerabilities in Midong. As one of the generally accepted methods in study of sociology, psychology and human behavior, questionnaire survey could also be adopted in study of municipal material consumption and flows due to its strong advantages in manipuility and expandability.

The study begun with a broad survey in order to generalize results to a population and then focused, in a second phase, on detailed quantitative and open-ended interviews to collect detailed views from households' members. The inquiry is based on aim-oriented questionnaires, which were designed to collect both inductive and deductive data, exploring the links between environmental attitudes and behavior from a more holistic perspective. On the basis of this approach, a conceptual framework of environmental behavior is outlined through the use of data collected from the survey.

6.6.2 Research Paradigms in Questionnaire Design: Qualitative & Quantitative Research Methods

In the preliminary steps to proposal design, we didn't impose or disaffect any research methods intentionally. The study tends nothing more in either quantitative or qualitative in nature, as "the situation today is less quantitative versus qualitative and more how research practices lie somewhere on a continuum between the two." (Creswell, 2003 p. 4) Consequently, we prefer to indulge what would turn out (research purposes) rather more than the research methods we would use.

How could we build a model or framework for observation and understanding, which shapes both what we see and how we understand it? That is the question we should think about as research design considerations. Design considerations refer to "specific requirements imposed upon the analytic process by the very nature of the research questions themselves". (Baptiste, 2001 p. 3) As environmental problem especially the approach on environmental behavior is more than a single nature science but concerning more social issues, such as intensions, attitudes and behaviors of human being. "Environmental issues are fundamentally social class issues" (Cable, et al., 1995 p. vi)

"Less well known than either the quantitative or qualitative strategies are those that involve collecting and analyzing both forms of data in a single study." (Creswell, 2003 p. 15) Either qualitative – open-ended interviewing or quantitative – measuring attitudes, rating behaviors provides comprehensive analysis. We have to make

collection of both qualitative and quantitative data sequentially, hoping that collecting diverse types of date provides an understanding of a research problem. Obviously, a mixed methods design is useful to capture the best of both quantitative and qualitative approaches.

6.6.3 Requirements and Principles on Questionnaire Design

Aiming at proceeding the survey smoothly, while more important, in order to accomplish an accurate and qualified data collecting, the questionnaire designing must capacitate the survey to provide sufficient information, while, with adequate efficiency. Dozens of basic principles we have followed for tailoring the design of questionnaires to study needs, and tried to expend the possibilities, in a way to facilitate the processing, at least not to challenge respondents' cognitive capability and psychological tolerance, as well.

A respondent-friendly questionnaire is objectives oriented, "attractive and encourages people to read words", (Dillman, 2007 p. 81) "improve the likelihood of getting an answer". (Dillman, 2007 p. 39) Obviously we don't have to worry about the vagueness in feedbacks as that is the assignment of interviewers. However, still bunch of following points we have to pay attentions to.

Avoid inconvenience. It's a good start that respondents don't have to read and fill in by themselves, so that they would not be confused by complex questions or vagueness. Meanwhile, all questions are carefully organized in easy-to-answer formats, avoid jargon and technical terms whenever possible, so that they would not challenge respondents' cognitive abilities and adopted indiscriminately regardless respondents' educational qualification. In a work, keep the respondent burden as low as possible.

Make questionnaires appear short and simple. It appears in according to the first principle but more important, it reduces the physical and mental cost of respondents significantly. It refers not only to the length of whole questionnaire, but also in designing of single question, "choose as few words as possible to pose". (Dillman, 2007 p. 53)

Minimize requests to obtain personal information. It is also necessary in survey to minimize the intrusive questions, which contains some type of prestige bias. If have to, such as questions about educational qualifications, explanations should be carefully offered for why the questions are important and how the information will be kept confidential or anonymous.

Last but not least, proposing questions that seem important to residents and chasing their environmental concerns. If they are handled in person, they have more motivation to participant the survey.

6.6.4 Total Questionnaire Structure

The questionnaire includes three main study constructs, waste efficiency, water efficiency and energy efficiency, building up together the core study context. In addition, the living condition and social characteristics is another part of the survey. Respondents' concerns and attitudes towards local environment condition would also be interview.

According to these study constructs mentioned above, the questionnaire has been divided into 7 (A – G) sections.

As the setting-stone of the survey, section A aims at ramping up the interview and obtaining general information about outdoor living condition of the community where the respondents live. Through the describing of intervenes, their satisfaction over outdoors environment would be available as well.

Section B extends to indoor environment, including questions about housing condition and number of family members. Heating system and electric appliances would also be surveyed as resources of energy-consumer.

Individual social-demographic variables are the major survey-goal in section C, such as age, gender, education quality, career and nationality of intervenes, which have evidently impacts on environmental behaviors. Besides, what are their biggest concerns over environmental problems would also be imposed in this section, so that a correlation could be confirmed between environmental attitudes and their social characteristics.

Section D includes questions relating to MSW. The keynote of this part is whether and how are MSW segregate collected in households. We are interested in residents' motivation of sorting waste and recycling behaviors and factors that keep them out of this, such as the efforts and gains through selective actions.

Questionnaires for water efficiency and energy efficiency are divided into next two sections. The source and usage of domestic water would be surveyed in Section E. To figure out residents' attitudes towards water efficiency is our another goal as well. For energy efficiency, in section F. we imposed particular interest in energetic renovation in the region.

Interview would be concluded with Section G including summary questions relating to general environmental concerns and attitudes. The residents are encouraged to express their engagement of local environmental improvements in further.

6.7 Statistical Analysis

Unfortunately, the primary data were not available for this research due to the local government's regulations. We use therefore only secondary data in this paper for further analysis, that provided by our local co-operating agency AEPS.

6.7.1 Descriptive data in Terms of Major Social-Demographical Variables

A number of social-demographic variables have been mentioned in the literature concerning both environmental concern and behavior. Among which we are most inertest in four most major variables, i.e. gender, age, educational level and nationality, which are considered as representative factors of the most valuable psychological variables effecting people's environmental actions. (Barr, 2002 p. 37)

Gender, age and educational level of intervene were surveyed at first in questionnaires as typical causational factors, which affect personal-sphere attitudinal variables leading to resident's environmental behaviors directly. More female participants have been responded to the surveys that are very likely the domestic

women who are more active in housework. This is in line with the results from another question showing that merely 27% of households are dual-career families.

Majority of respondents are between 30 to 50 years old. People in this age have mostly established the worldview that they think they should insist on, including the attitudes towards environment issues. Some theories treat environmentalism as a matter of worldview. (Stern, 2000 p. 411) Thus, their attitudes on one side reprehensive the bandwagon in the society, however, on the other side, we need to realize that they are hardly for changing. However, the relationship between age and pro-environmental behavior is uncertain. Many previous studies have investigated this relationship, while it appears that the results are mixed. Some researchers claimed that those involved in environmental behaviors are young people as they are more highly educated about the importance of environmental activity. (Hines, et al., 1987 pp. 1-8) In contrast, a number of studies have alluded to a positive correlation between age and scores on their "self-reported actual commitment" (SAC) index, indicating that age is a significant sociodemographic variable as older people had higher SAC values. (Schahn, et al., 1990 pp. 782-783)

	C1	C2	C3	C4	C5	C6
Sample Size	36	42	26	37	33	37
Social Characteristics	%	%	%	%	%	%
Gender	100	100	100	100	100	100
Male	23	38	42	78	27	58
Female	77	62	58	22	73	42
Age	100	100	100	100	100	100
18-29		5	19	14		3
30-40	49	21	38	36	27	36
40-50	31	31	15	39	58	50
>50	20	43	28	11	15	11
Educational qualification	100	100	100	100	100	100
Illiterate		2				6
Under or equal to JHS	49	38				72
Equal to SHS	36	14				14
University degree or above	15	46				8
Nationality	100	100	100	100	100	100
Chinese-Han	94	93	77	58	100	58
Uygur	6	0	0	0	0	31
Hui	0	7	23	42	0	11

Table 13. Resident's Social Characteristics in Six Study Communities

Diversity of nationality on one hand entails Urumqi with multi-cultural prosperity, but on other hand causes divisiveness in different living groups. One considerable reason might be in precisely the way among which the habits quite differ from each other. “Many environmentally significant behaviors are matters of personal habit or household routine” (Stern, 2000 p. 415) For example, the distinction between attitudes and habits as causes of behavior closely parallels the distinction in a variety of “dual-process” (Smith, et al., 2000 pp. 110-112) models between conscious and effortful behaviors and automatic or associative ones. In addition, inequality of income and in educational opportunity between different ethnic groups is variable, but also associated with environmental concern.

Clearly there are a number of other variables have been mentioned briefly in the literature, which have been correlated to environmental concerns or to predict environmental behaviors, like household composition and tenure, or spiritual religiosity could also be conducted as further criterion. However, there are always severe restrictions for practical and ethical reasons, as “many environmentally relevant behaviors take place in privacy which should not be invaded”. (Schahn, et al., 1990 p. 785)

6.7.2 Physical living Surroundings

The participants could appraisal their living surroundings in first two sections of questionnaire in terms of their satisfaction about indoor and outdoor circumstances. Over 90% people are basically satisfied with their houses, only few complaints are collected showing but almost no common grounds among which, and are most relating to contractual or infrastructural problems.

Most of residents like over 65% from C1, C2, C4 and C6 are satisfied with the environmental sanitation in their community. This would be most thankful to the agencies that in charge of community property management, who cater to their own inclination within community. In contrast, the other communities C3 and C5, where there is no community management available, the rates of satisfaction about environmental sanitation are quite low, indicating only 38% and 28% respectively.

Mean Value	C1	C2	C3	C4	C5	C6
Build-up Area	68 m^2	95 m^2	88 m^2	123 m^2	67 m^2	88 m^2
Rooms	5	5-7	5-8	2-8	6	4

Table 14. Average Area and Number of Rooms per Household

Except for C6, all communities are centrally heated through the district heat supply network, which covers most storied building areas (heating area of 50 million m^2 by 2005) with coal burning. (Li, 2005 p. 20) Domestic stoves burning coal are prevalent in the traditional one-storage housing areas C6.

6.7.3 Local Environmental Concerns

In our study, we used the scale consisted of 16 questions representing typical environmental impacts including air pollution caused by industry, air pollution caused by coal burning, air pollution caused by car exhaust, air pollution caused by sand storm, river pollution, (ground) water pollution, drinking water pollution, MSW arbitrary dumping, hazardous MSW, toxin in soil, indoor air pollution, flood, drought, soil Stalinization, global warming and glacier melting, for respondents to evaluate, to what extent are their daily life have been influenced by these environmental impacts listed above, in a five-level evaluation scale from “no influence” to “huge influence”.

We assume a scale definition for 16 items that a higher scale score indicates a higher or stronger evaluation of the influences on people’s ordinary life caused by one of environmental events on the list. Therefore we are able to connect the following scale rating categories with a set of score-system, so that they could be valued comparably, i.e.:

4 scores for — huge
3 scores for — much
2 scores for — some
1 scores for — slight
0 score for — none

The scores on scales measure how environmental impacts matter resident's life. It's a measurement instrument with the capability of differentiating the topics of environmental impacts and concerns. The higher one environmental impact is scored, indicating a higher level of influence caused by which to human beings and their live. It turns out the results that I am showing in the following graph, demonstrated the utility of the constructed scales.

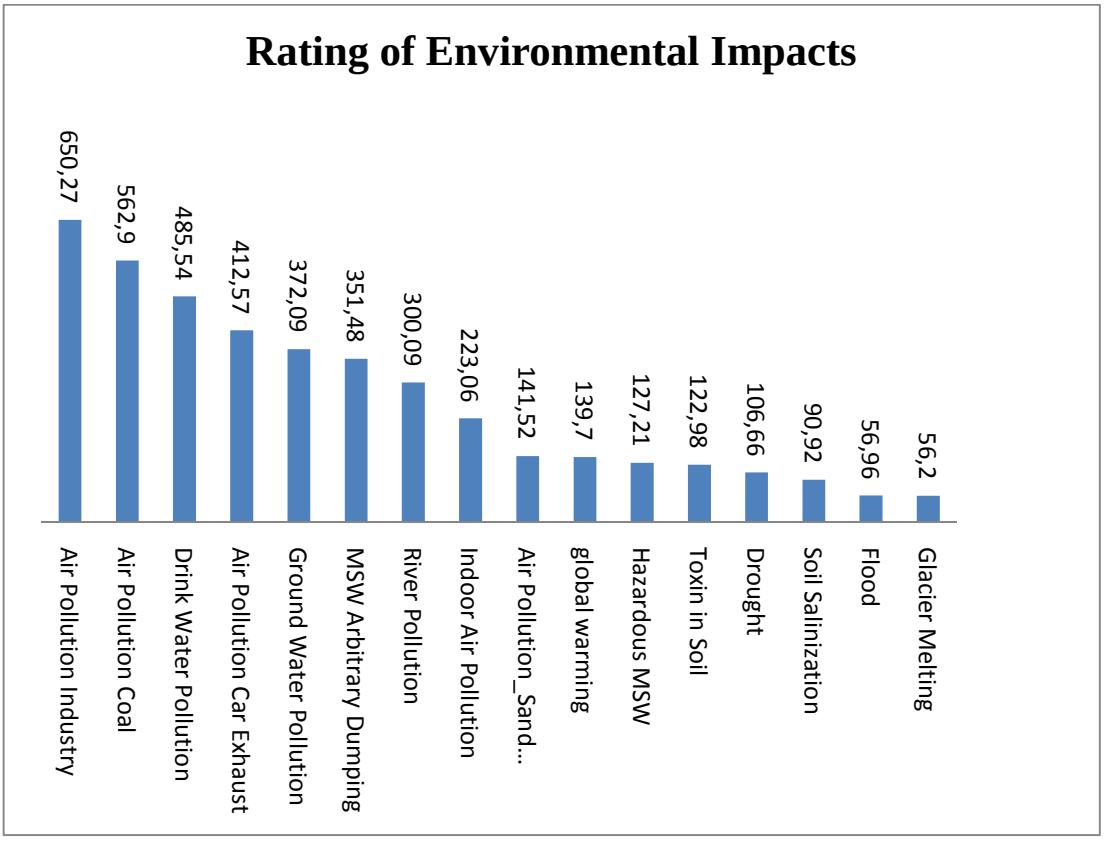


Figure 9. Rating of Environmental Impacts

Air pollution is mostly concerned by people living in Midong, no matter it caused by what reasons. People are aware that most man-made pollutants like particulates resulting from industrial activities or incomplete combustion of fossil fuel, which contain a variety of organic compounds and metals. (Holdren, et al., 2008 p. 13) And more important, people know exactly that the severe air pollution has the potential to affect their health, or even could be significant causation of mortality and morbidity.

Besides, some studies showed that in the usual urban environment much of the pollution comes from traffic. (Beelen, et al., 2008 pp. 196-202) Result has also turned out that people do worry about the pollutants coming from car exhausts, even though Midong is hardly traffic intensive. It could also be overrated that people are getting severe stresses on the issue because of poignant anxiety over air pollution, so that they could blame everything that connected. In addition, even indoor pollution is rated high which may indicate increased concern over the adverse health effects. However, compare to outdoor impacts, indoor air quality is more complex; there is seemingly also the "influence of outdoor air-pollutant concentrations on indoor concentrations." (Taneja, et al., 2008 p. 228) From this point of view, we do have reasons to believe there are such perturbations as people think about the indoor air condition affected by ambient air pollution. Nevertheless, it concludes clearly that air pollution is the primary pollution in the eyes of people in Midong.

All water related pollutions are also highly rated, including drinking water pollution, (ground) water pollution and river pollution. Pollution intensive industries produce not only pollutants into air, but also depredate the water quality, especially in Midong, where rapid industrial expansion happened, pollutants and toxicity are potentially released into aquatic circumstances through industrial sewage with only primary treatment or not at all. Drinking water quality matters direct the human health where most concerns emerged. However, there are no reports in recent years indicating a direct severe pollution of drinking water, which implies that people are actually concerning about the consequences of pollution in sources of supplied drinking water, such as polluted ground water and river water. For instance, the small Shuimo River Basin is one of the most polluted areas in Urumqi, where dozens of heavy industries, chemical industry, textile industry, as well as paper and cotton factories are concentrative located.

Comparing to air pollution and water pollution, MSW problems are not highly ranked. Indeed, if most of MSW are collected and dumped in the far-off rural area, it causes no direct or visible influences on human being. Nevertheless, the problem of arbitrary dumping of MSW is issued by many respondents. It indicates a lower collection rate of MSW, which caused not only by inaction of the government on this

issue, but rather because of technological and physical incapability of the government on MSWM.

Impacts caused by climate changes like global warming and glacier melting as well as the sequent extreme weathers, such as flood and drought are not highlighted in our survey, even though the respondents live in such an environment sensitive area, who are especially vulnerable to many of the likely adverse impacts of climate changes. Coal burning releases not just harmful particulars in the air, while it is also responsible for most on China's contribution to global greenhouse gas (GHG) emissions. However, compare with air pollution which could be easily recognized by naked eyes, like the heavy smoke during the heating period, the climate change impacts look like rather than a theory for most of people in Midong.

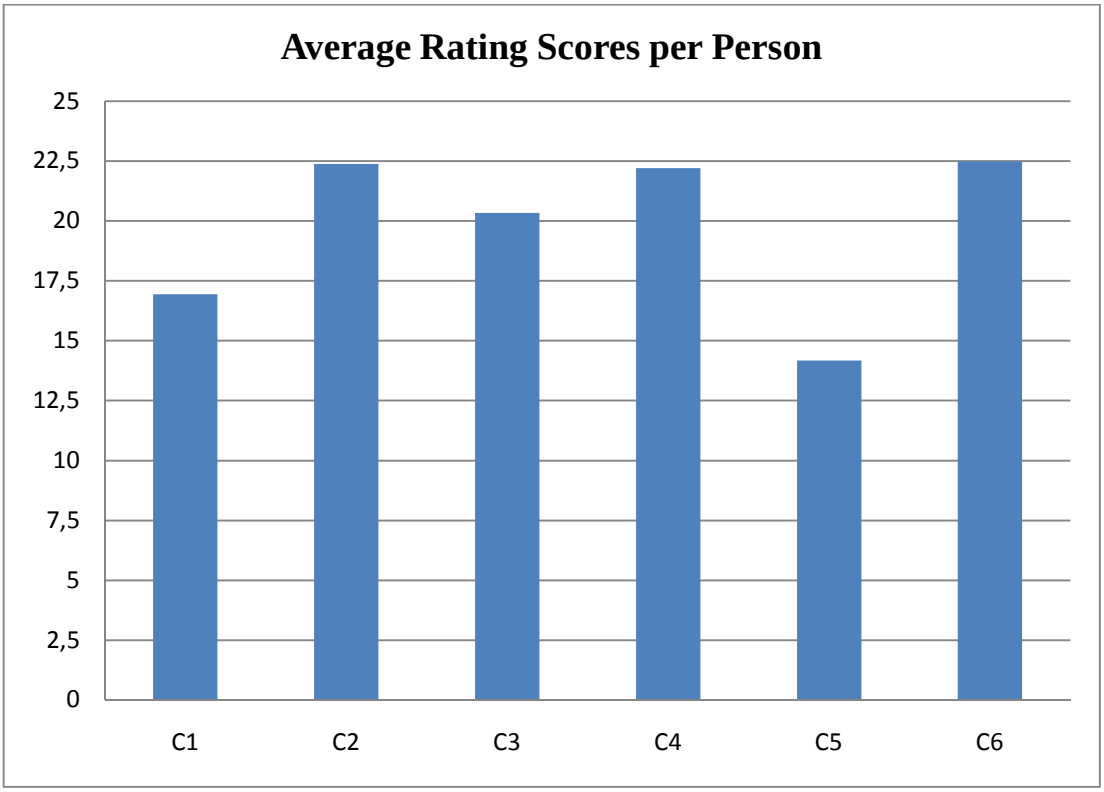


Figure 10. Average Rating Scores per Person in Terms of Different Community

Figure 9 presents the average rating scores have been given per person from different community. People coming from local workers and staffs' families (C1 and C5)

expressed concerns about environmental impacts not as much as what have been collected in other communities. Comparing to the results from other communities, it is notable that their composite average scores per person are 5-7 points below the average composite score from other communities.

The level of rating scores present on one side the true influence of environmental impacts on people's live; on other side they are implying the attitudes of people towards environmental events. Lower scores from C1 and C5 mean that even people are aware of the impacts but they are not anxious to change them. As coal miners or factory workers their income of family is coming from nothing short of the real "sources of pollution". This bias in the results indicate that their attitudes towards environmental impacts are inevitable influenced by pecuniary interests. E.g., the average score of C1 and C5 for air pollution caused by coal burning accounts for 2.19, which is almost one point lower than the average of 2.9 scored by other 4 communities. Generally, "information relevant to the behavior in question is without doubt a prerequisite for undertaking that behavior." (Barr, 2002 p. 46) However, in our study, even though many people are coal miner themselves, who learn more about the hazards of coal burning than ordinary people, it doesn't indicate any positive correlation between environmental knowledge and environmental responsible behavior or attitude. It implies on side a weak knowledge-behavior relationship, while on other side, the results from C1 and C5 might be distorted due to the economic dependence of households on the local industry.

6.7.4 Data Analysis in Terms of MSW

The average household size in the study areas is 3.50. Results show that the households generate an average of 1.2-1.5 kg solid waste per day. The type of wastes commonly generated are kitchen residuals, papers, PET bottles, metals and cans, glass bottles, plastics etc. Households dump the waste in waste containers that planted in their neighborhood or in front of their apartment buildings. Basically they rely on garbage-collection services of the government.

MSWM refers to the efforts that have been made in public sphere. However, individual behaviors like purchase, use, and disposal of personal and household products also lead to environmental consequences. Individual behaviors from

private-sphere impact the environment slightly but in a direct way and would have environmentally significant impact in the aggregate, if many people independently do the same things. (Stern, 2000 p. 410)

The households in Midong segregate wastes into PET bottles, paper and board, cans and metal and leave other wastes mixed. Obviously, it is not complete segregation, since the mixed part of wastes comprises both biodegradable and non-biodegradable substances.

The proportion of households that engage in segregate collection of valuable wastes is summarized in Table 15 below. The segregate collected wastes are usually sold to waste collectors or junkshop owners for extra gains. According to the results of the study, it brings one household 20 - 30 Yuan a year, which is quite exiguous.

	PET Bottles	Paper & Board	Cans	Metal
Proportion of Households engaging in segregate collection	77%	78%	72%	68%

Table 15. Proportion of Households Segregate Collecting Waste

There are some interesting results demonstrated by the survey showing the contradiction and confusion of people's attitudes toward segregated collection and recycling behavior. Around half of the people announced that segregated collection and recycling of waste are definitely the duty of government. Therefore, the ordinary citizens could choose their behavior due to individual opinion or responsibility on environmental and social issues. However, it's not their obligation to do that. In the meantime, 73% people also believed that they would segregate their waste into different groups, like for example what illustrated in Table 15, before the government collects them. It's saying that at least half of the people wouldn't accept the obligation of waste classifying, but meanwhile, they would like to continue to take the advantage of selling those materials that they have segregated all the time. If so, they were glad to classify and recycle the waste.

More evidences validate the same statement. 73% people preferred to do segregate collection by themselves than to pay for recycling service to government. They were really reluctant to abandon the vested economic benefits, although 20 to 30 Yuan a year is exiguous income, even in Urumqi.

The ambiguous attitudes towards segregated collection may result from ambiguous understandings of segregated collection and recycling. People are basically satisfied with the current process and are really reluctant to do further classifying activities that profit them no extra economic advantages. A good case in point is that there are 40% people against imposing fines for non-classifying behaviors. Lacking of benefit and know-how on classifying activities make people hesitate to press forward and would rather leave the responsibility to the government. On the other hand, there are no adapting programs helping people to apply themselves more willingly into play. 57% people announced that they would like to segregate waste, just don't know how to do it. While also 41% people thought that waste classifying is meaningless and they are not interested in doing it. People are obviously innutritive of necessary knowledge on this issue, and they know this fact and actually 69% of them laid the blame on deficient education of children in school, which indicates somehow that "people are failing to adopt these practices because they lack sufficient knowledge and understanding of how to incorporate them into their daily lives." (Simmons, et al., 1989-1990 p. 328)

Thus, the government should on one side not stop striving on adapting programs by themselves, and more important, on other side, it is also urgent to provide more economic incentives to encourage positive action on matters of education on waste classifying and recycling. One of the possible final goals might be likely to make people to realize that living in the global community brings certain behavioral responsibilities, i.e. "the duties associated with active citizenship to include responsibilities for the environment." (Selman, 1994 p. 46) Instruments that could be adopted, for example, like one general applied idea is that put more efforts through media. Actually, without media coverage it is unlikely that an erstwhile problem will either enter into the arena of public discourse or become part of the political process. (Hannigan, 1995 p. 58)

6.7.5 Water and Energy Efficiency

Citizens are urged to find out the facts and to increase their awareness by appreciating the various savings that can be made by, for example, switching off lights or using a water butt. Actions are recommended and sources of further information are provided. The survey helpfully recognizes the significance of need for incentives and the necessity for environmental action to be seen as normative behavior alongside awareness raising. This is encouraging, since a definitively information action approach is unlikely to be effective.

According to the reports of water and energy consumption, the water consumption is 48.80 m^3 per household a year, 15.48 m^3 per person a year. 31% people drink sometimes bottle water, although there are no evidences indicating an inevitable connection, there are indeed 45% people complained about the water quality of poor or terrible. Television, washing machine and refrigerator are most common household electric appliances; more than 85% households own these three appliances. Other electricity eat-up appliances like computer and air conditioner have lower penetration, about 24% and 12% for each. Besides, 54% households use liquefied petroleum gas for cooking. All communities, except for C6, are centrally heated by public operating. Average indoor temperature during the heating period reaches 20, however, the temperature is also central controlled, and it's not possible for individuals to adjust it in house.

Economic consideration is the main source of efficiency actions in water and energy consumption, according to relating results. 74% people announced that they save water because water price is getting expensive. Same explanation has been given by 71.50% people for performing energy conservation actions. However, still a lot of people realize that water-saving or energy conservation activities are environment relevant. Possible reason might be that they find intrinsic motives to do so and more importantly, to continue to do so. For example 66% people do this because of water scarcity in the region, and 62.25% people think that over consumption of energy deteriorate indoor and outdoor air quality badly. It indicates that for this people, "conservation behavior might be found potentially satisfying to a broader cross-section of the population". (De Young, et al., 1985-1986 p. 240)

Well these are actually not only rubber check, but people indeed have attempted to reduce their consumption of water and energy. Lots of people initiatively reuse the waste water for irrigation or toilet flushing. 94.67% households equipped with energy-saving lamps. With a rational price, 80% are ready to purchase or update their household appliances to save more water or energy.

6.7.6 Further Analysis towards Residents' Environmental Attitudes in General

In the last section the expectations of people over further improvements in different environment related sectors were gathered by using the score-system analogic to which conducted for environmental impacts evaluation. This includes potential improvements on seven indicators in the region, public traffic, purchasing environment, air quality, water quality, MSW treatment, community environment and urban landscape. Through this survey, we would be able to know, which indicator should obtain preferences in further urban development according to people's expectations.

Analogically, we assume a scale definition for seven indicators that a higher scale score indicates a higher or stronger expectation of the improvement on this sector. Therefore we are able to connect the following scale rating categories with a set of score-system, so that they could be valued comparably, i.e.:

4 scores for — most important
3 scores for — very important
2 scores for — important
1 scores for — a little important
0 score for — not important at all

According to the assumption, it turns out the graph as follow:

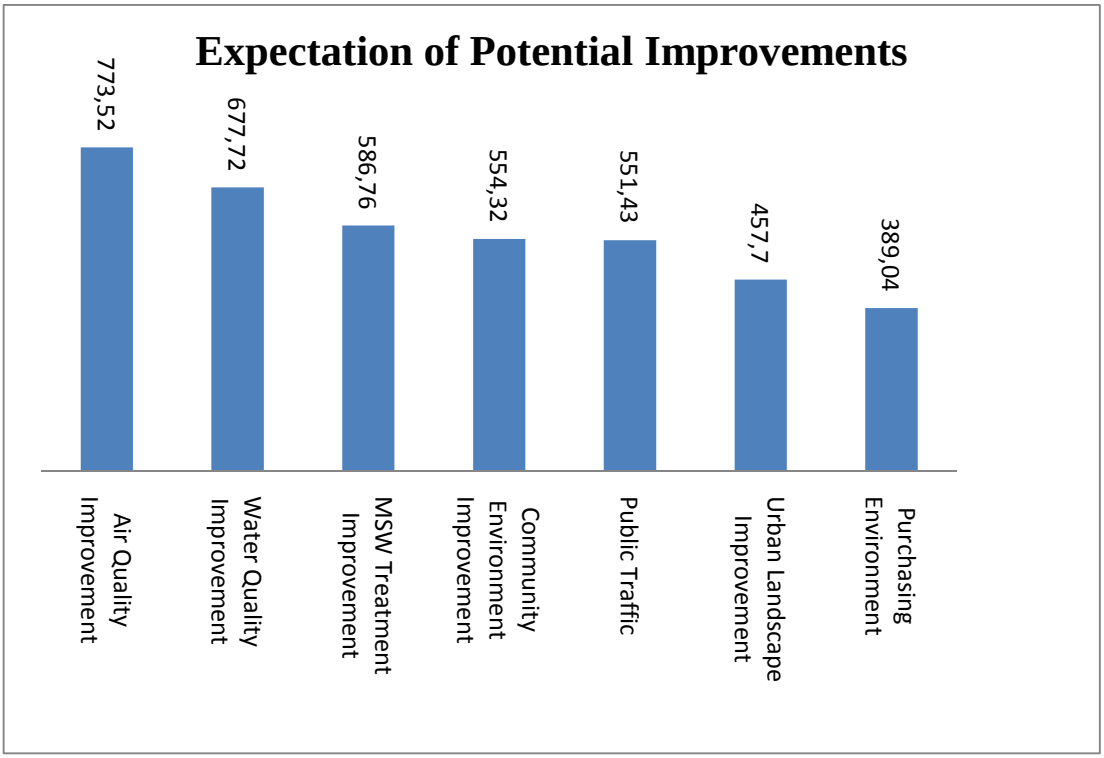


Figure 11. People's Expectation of Potential Improvements of Diffenrent Sectors

One of the common aspects covered in the survey is that air pollution is urgent to be improved, which is in accordance with the evaluation of environmental impacts. The similar results turn out that the improvements of water quality and MSW treatment have also priority compare with other public service, such as traffic, urban construction and shopping possibilities. Community environment is a mixed factor which consists to air condition, water supply, waste collocation and further more components. People need a comprehensive improvement on several factors that involved in their nearby-sphere, which is most close to them.

7 Summary

Environmental impact has been — almost in whole human history, a by-product of human desires for physical or mental necessaries and comforts. Only since very recent, has “environmental protection become an important consideration in human decision making”. (Stern, 2000 p. 408) It has been realized in very recent in China, since merely twenty years, as environmental impacts became major challenges to the country. When we are looking back to the development in the past 30 years in China, as consequences of economic growth, tremendous economic transition and social changes are evident. However, what also evident are clouded air, sewaged river and soil, or scattered garbage hills around the cities.

In addition, the faster pace of globalization, the growing interdependence of human being from different country and continent, plus increased human activities in greater scale have enlarged the effects of regional environmental deterioration and spread them around the world in a high speed, which caused extreme events, disasters and unrepairable losses of nature. Some environmental impacts left even long-term effects.

People living in western China, like in Urumqi, have been suffered from those consequences of global environmental deterioration, which also made them extreme vulnerable to climate change. While, on the other hand, arbitrary economic expansion and unplanned urbanization in the region have also contributed a lot to environmental deterioration. MSW became one of the most serious environmental problems in Urumqi, as the result of the over-increased generation and incapability of discharge and treatment.

The benefits of a common set of high-quality mandatory regulations and technical standards are very significant in environment protection. Nevertheless, depending on the general environmental situation, old regulatory framework and even traditional way life, practical implementation of adequate environmental projects and activities poses considerable challenges. These practical challenges relate to the coherence of the regulatory framework and the stat of preparation of relevant institutions,

enforcement and technical capacity. Building-up of codified and non-codified statements by legislator and relating institutions since 1990s, has made a significant effects on environmental protection in China.

The new guideline for economic development with respect of environment protection, pointed out a new way for further development, as long as “Circular Economy Promotion Law” passed into lows in 2007, aims at promoting “sustainable development” at the highest governmental level. This ambitious program, integrating environmental, social and economic goals, faces many challenges, from basic definition to practical implementation. Government reiterated the importance of a common set of principles-based guidelines in support of the coherence and consistency of economic development and environmental improvements through efficient allocation of resources and facilitating investment needed. More emphasis and priority on “reduce” and “reuse” as well as other efficient instruments promoting economy development sustainably, would provide new engine for further development. In meantime, it also requires more spontaneous instinct from the market, e.g. making more private sectors and non-administrative institutions getting involved.

However, many developing countries and countries during economic transition lack a critical mass of competent accountants and expertise capable of applying highly sophisticated proceedings to attain their environmental goals. The need for a global set of specific cooperation has long been apparent. The process of international convergence towards standards preventing climate change happened already frequently, while is not even close to success. Cooperative process need to be speed up to help developing countries and countries with economic transition in building the necessary capacity and institutions needed for implementing adept programs and imposing environmental improvements in accordance with their economic and social goals.

Urumqi faces besides the stress of increasing MSW generation, a variety of capacity-related issues, like technical challenges, regulatory incompetence. A related technical problem is the limited availability of training materials and experts on the issue. Shortage of expertise and researches in the field of environment protection affects not only the operative sector, but also regulators and other government agencies.

Further environmental improvement needs more adept decisions on technological advances or economic adjustments for lasting effects on the environment.

The main environmental impacts and problems that arise behind economic development in Midong that have been identified in the survey discussed in chapter 6 and lessons have been learned, as the results of survey reflected, there are growing awareness that environmental problems have more to do, with the decisions both of authorities and ordinary people. Environmental protection and improvement cannot be realized only through top-down processes, as it used to be in China, but also down-top effects, which could be more efficient, as “the resolution of environmental problems involves not merely technical or economic adjustments, but real shifts in attitudes and behaviors of all people.” (Barr, 2002 p. ix) Further approaches might be focus on, for instance, how to promote the behavioral shifts necessary for creating the sustainable society or local sustainable in household and community.

In addition, an in-depth and detailed analysis of thesis issues, such as industrial materials flow could be a subject of further research and discussion.

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List of Figures

List of Tables

List of Acronyms and Abbreviations

AEPS	Xinjiang Research Academy of Environmental Protection Sciences
BAS	Beijing Academy of Social Sciences
CAS	Chinese Academy of Sciences
CAES	Chinese Research Academy of Environmental Sciences
CGT	Compressed Garbage Trucks
CEP	Circular Economy Promotion Law of the People's Republic of China
C&I	Commercial & Industiral
EGT	Enclosed Garbage Trucks
EHD	Environmental Health Administrative Department
EPB	Environmental Protection Bureau
EPL	Environmental Protection Law of the People's Republic of China
ERPC	Environmental and Resources Protection Committee
FC	Fixed Charge
FWDC	Food Waste Comprehensive Disposal Center Urumqi
GDP	Gross Domestic Product
GDT	Garbage Dump Trucks
GHG	Greenhouse Gas
GTS	Garbage Transfer Station
HWL	Hazardous Waste Landfill
IIED	International Institute for Environment and Development

IP	Inhalable Particles
IUWA	Institute for Eco-Industrial Analysis
JHS	Junior High School
MEP	Ministry of Environmental Protection
MFGT	Multi-Function Garbage Trucks
MGT	Medical Garbage Trucks
MOHURD	Ministry of Housing and Urban-Rural Development
MSW	Municiple Solid Wast
MSWM	Municiple Solid Wast Management
NBSC	National Bureau of Statistics of China.
NO2	Nitrogen Dioxide
NDRC	National Development and Reform Commission
NPC	National People's Congress
PAYT	Pay-As-You-Throw
PET	Polyethylene Terephthalate
PEP	Law of the People's Republic of China on Prevention of Environmental Pollution Caused by Solid Waste
PPP	Polluter-Pay-Principle
PRS	Public Recycle Station
SAC	Self-Reported Actual Commitment
SHS	Senior High School
SO_2	Sulfur Dioxide

SWMC	Urumqi Solid Waste Management Center
WPC	Waste Picker and Collector