

A Consumption Analysis of



Hong Kong and Guangzhou

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A Consumption Analysis of Hong Kong and Guangzhou

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Abstract

Hong Kong and Guangzhou, China, have experienced rapid increases in population and resource consumption. This Interactive Qualifying Project completed a consumption analysis of these cities and suggested methods to reduce consumption and improve sustainability. Civic Exchange sponsored the project to promote more ecologically responsible policy dialogue in Hong Kong. Consumption data for Hong Kong and Guangzhou was gathered and compared using archival research and interviews and compiled into a consumption analysis focused on urban biomass, water, energy, materials and food.

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Executive Summary

Humans have offset the natural cycle of life through unsustainable resource consumption. As a species, we consume resources we need and often replace them with waste that ecosystems cannot process. We have tapped large amounts of natural resources and species to exhaustion and even extinction. This selfish attitude towards the planet has left irreparable scars on the world ecosystem. In order to stop such abuse, we first need to figure out how much impact we actually had. A consumption analysis is a method of measuring how many resources a population consumes and serves as way to develop foci for sustainable and renewable development strategies.

Hong Kong and Guangzhou are two of the biggest ports in South East Asia. Both areas have a large population that continues to increase. This population increase results in a consumption increase which exponentially grows in its difficulty to be managed. It is therefore important to study consumption and production patterns in these two areas because both exhibit production and consumption patterns that negatively impact the world's ecosystem.

For our consumption analysis of Hong Kong and Guangzhou, we analyzed five different aspects of resource consumption: urban biomass, water, energy, materials, and food. Once the data had been collected and analyzed, we were able to draw conclusions about Hong Kong and Guangzhou's consumption patterns and make suggestions about how these patterns could become more sustainable..

In 1999 Hong Kong and Guangzhou had populations of nearly 7 million. The urban density of both areas was well over 20,000 people per km². For Hong Kong this poses a problem since the population is set to reach 10 million by 2030, yet it has a relatively small land area for accommodating all of these people. In order to incorporate sustainability into land use planning Hong Kong must look into incorporating ecological planning into the early stages of land development. Comparatively, Guangzhou has a larger land area and uses much of its land for agriculture and industry, whereas Hong Kong does not. Hong Kong already has 83 percent of its land allocated, with a large portion being used for housing and country parks.

Hong Kong and Guangzhou face problems with sustainability of their water usage. Hong Kong gathers 27 percent of its water from rain water collection, the other 73 percent coming from the Dong Jiang River in Guangdong. As its population grows, the dependency of Hong Kong on outside water sources will increase. For Hong Kong to become more sustainable it is important for the public to become aware of the water resources, supply problems, and quality. Hong Kong could also increase the amount of sea water that it uses for toilet flushing to save more of the potable water for human consumption. The water situation in Guangzhou is quite different because it sits beside the Pearl River tributary, which supplies ample water for its population. Only 40 percent of this water supply is treated, however, for this reason there is a shortage of potable water to supply to the public. Guangzhou needs to improve and expand its water treatment facilities by developing a government department in charge of this task.

Hong Kong's and Guangzhou's energy resource consumption is heavily based on fossil fuels. Hong Kong mainly consumes oil products and has recently begun a transition phase in which cleaner and more efficient fossil fuels are used for electricity generation, transportation and town gas purification processes. This has resulted in diminished air pollution emissions, especially public transportation. On the other hand, Guangzhou energy production is largely based on coal products. This is due to China's substantial coal reserves. The coal combustion techniques need improvement as they cause significant industrial air pollution. Much of Hong Kong's poor air quality is directly related to the air emissions coming from the Pearl River Delta.

Both Hong Kong and Guangzhou need to develop more sustainable methods for producing the energy they consumed. Both areas consume energy produced from fossil fuels, which are ultimately in limited supply. They need to begin integrating non-fossil fuel based energy production technologies into their systems in order to ensure a smooth transition into a sustainable energy era, which will undoubtedly be marked by a significant increase in the cost of fossil fuels.

In order to supply its population with food Hong Kong must import almost all of its commodities from other regions of the world, with mainland China being its biggest source of food. Guangzhou, on the other hand, produces a lot of the food its population consumes and also exports food to other areas. Guangzhou's local production makes

food consumption more economically sustainable by creating jobs and cutting transportation costs. People in Guangzhou eat more cereal grains and less meat and seafood than Hong Kong making their diet more sustainable. Yet both areas consume food that is produced with the use of unsustainable inorganic farming and animal husbandry methods.

Hong Kong and Guangzhou consume immense amounts of new materials with very little of this material being reused or recycled. At present Hong Kong only recycles about 34% of its municipal waste, which included materials such as paper, plastics, glass, and wood as natural resources become depleted excessive consumption of new materials such as found in Hong Kong and Guangzhou is unsustainable. However, recycling steps are being taken to help correct the over consumption through waste recycling and reusing more materials.

Overall, Hong Kong's and Guangzhou's resource consumption patterns are unsustainable. Hong Kong and Guangzhou need to shift their focus to becoming more sustainable cities. By using sustainable planning and development practices both regions could continue to grow and at the same time reduce their negative impact on the environment.

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Table of Contents

A Consumption Analysis of Hong Kong and Guangzhou	i
<u>Abstract</u>	ii
<u>Acknowledgements</u>	iii
<u>Executive Summary</u>	iv
<u>Authorship Page</u>	vii
<u>Table of Contents</u>	viii
<u>Table of Tables</u>	x
<u>Table of Figures</u>	xi
<u>Chapter I Introduction</u>	1
<u>CHAPTER II BACKGROUND AND LITERATURE REVIEW</u>	4
<u>2.1 Resource Consumption</u>	4
2.1.1 Koenig and Warren’s Method	5
2.1.2 Friends of the Earth Method	5
2.1.3 Wackernagel’s Method	6
2.1.4 World Wildlife Fund Method	6
2.1.5 Limitations of Ecological Footprints	8
2.1.6 Advantages of Ecological Footprints	9
<u>2.2 Sustainability</u>	10
2.2.1 Hong Kong’s Development	10
2.2.2 Sustainability in Hong Kong	12
<u>2.3 Consumption Analysis of Hong Kong</u>	14
2.3.1 Food and Nutrients	14
2.3.2 Water	17
2.3.3 Energy	19
2.3.4 Materials	22
2.3.4 Materials	23
2.3.5 Urban Area	23
<u>2.4 Interactions between Guangdong and Hong Kong</u>	24
2.4.1 Appropriated Land from Guangdong	24
2.4.2 Food Provided by Guangdong to Hong Kong	25
2.4.3 The Impact of Food Production for Hong Kong in Guangdong	25
2.4.4 Drinking Water and Water Used for Food Production	26
<u>2.5 Conclusion</u>	26
<u>CHAPTER III METHODOLOGY</u>	28
<u>3.1 Introduction</u>	28
<u>3.2 Project Focus</u>	28
<u>3.3 Interviews</u>	30
3.3.1 Interview Protocol	31
3.3.2 Assessment of Interviews	32
3.4.1 Gathering Data	33
3.4.2 Data Analysis	33
3.4.3 Calculations	34
<u>3.5 Presentation Format - Prototype</u>	37

<u>CHAPTER IV RESULTS AND DISCUSSION</u>	38
<u>4.1 Urban Biomass</u>	38
4.1.1 Urban Biomass – Summary	46
<u>4.2 Water</u>	46
4.2.1 Water Supply – Summary	52
<u>4.3 Energy</u>	54
4.3.1 Energy - Summary	65
<u>4.4 Materials</u>	66
4.4.1 Materials - Summary	73
<u>4.5 Food</u>	74
4.5.1 Food - Summary	81
<u>4.6 Sustainability</u>	82
4.6.1 Urban Biomass	83
4.6.2 Water	84
4.6.3 Energy	88
4.6.4 Materials	93
4.6.5 Food	95
4.6.6 Conclusions	97
<u>CHAPTER V CONCLUSIONS AND RECOMMENDATIONS</u>	98
<u>5.1 Conclusions</u>	98
<u>5.2 Recommendations</u>	99
<u>References</u>	101
<u>Bibliography</u>	105
<u>Appendix A</u>	107
<u>Appendix B</u>	109
<u>Appendix C</u>	110
<u>Appendix D</u>	113
<u>Appendix E</u>	123
<u>Appendix F</u>	124
<u>Appendix G</u>	130
<u>Appendix H</u>	131
<u>Appendix I</u>	135
<u>Appendix J</u>	136
<u>Appendix K</u>	137
<u>Appendix L</u>	141
<u>Appendix M</u>	147

Table of Tables

Table Number	Table Title	Page Number
1	Comparison of per capita food supply, daily per capita calories, protein, and fat for various countries in 1997	15
2	Food and nutrient consumption in Hong Kong, kg/capita per year	16
3	Water consumption in Hong Kong in 1971 and 1997 given in million cubic meters per year (A) and in liters per capita per day (B)	19
4	Energy in Hong Kong, 1971 and 1997	21
5	N-discharges and water appropriation in various locations for food, water and fiber consumption in Hong Kong, 1997	27
6	Oil product conversions	36
7	Hong Kong's retained imports in 1999	56
8	Guangzhou's imports, exports and retained imports in 1999	58
9	Energy conversions in Hong Kong in 1999	59
10	Guangzhou's energy conversions in 1999	60
11	Hong Kong energy end use consumption in 1999	63
12	Energy end Use in Guangzhou in 1999	66
13	Energy consumption summary	67
14	Sources of Hong Kong's food imports in 1999	81
15	Guangzhou's Exports	81

Table of Figures

Figure Number	Figure Title	Page Number
1	The breakdown of Hong Kong's food appropriation	17
2	Overall energy flow in Hong Kong in 1997	23
3	Developed (built up land) vs. Undeveloped Land for 1999 in Hong Kong SAR	40
4	Population Density map for Pearl River Delta area	41
5	Usage of developed land for 1999 in Hong Kong SAR in percent of total developed land	42
6	Use of undeveloped Land in Hong Kong SAR in 1999	43
7	Freshwater resources consumption in Hong Kong SAR	49
8	Freshwater consumption growth rate in Hong Kong SAR	50
9	Daily water consumption in Hong Kong SAR	51
10	Annual tap water consumption of Guangzhou	52
11	Daily per capita water consumption for the total population of Guangzhou	52
12	Total water consumption for Hong Kong, SAR and Guangzhou	54
13	Per Capita water consumption for Hong Kong, SAR and Guangzhou	54
14	Energy end use consumption in Hong Kong by sector a: in 1995, b: in 1999	63
15	End energy use by land passenger transport modes, Hong Kong and 52 urban regions, 1995	65
16	Principal statistics for all manufacturing establishments in 1999	70
17	Principal statistics for industrial production in Guangzhou in 1999	71
18	Import, export, and re-export figures for crude materials, inedible materials, chemical and related products in millions of Hong Kong dollars	73
19	Guangzhou Import and Export Totals to/from Hong Kong	74
20	Hong Kong and Guangzhou Total Imports and Exports	74
21	Hong Kong's Food Consumption for rice, livestock, fresh vegetables, and fish	76
22	Guangzhou's Food Consumption for poultry, pork, eggs, and seafood	78
23	Hong Kong's Local Food Production	79
24	Guangzhou's Local Food Production	79
25	Hong Kong's Imports of Food	80
26	Guangzhou's Exports of Food	80

Chapter I Introduction

The earth has been bombarded with human activity and an ever-growing population. A large majority of the lush vegetation and natural landscape has been molded to fit our way of life. Skyscrapers and pavement cover a land where animals used to find their food. There are holes in the ozone layer due to the exhaust of cars and air pollution we are responsible for producing. Our natural resources are running out. After all of this damage, we are just starting to realize that treating the symptoms rather than the causes will not be sufficient.

The first step in treating the causes is to examine how much impact we have made on the planet. After a thorough evaluation of how many natural resources are being consumed we can start to develop better, more sustainable ways to supply our needs.

A consumption analysis is a way to quantify the impact of humans on the planet. It measures and analyzes a given region's level of natural resource consumption and then compares it with other parts of the world. The need for consumption analyses is greater now than it has ever been. Resources are becoming scarcer, and as the world becomes more populated, we are running into the problems of how to handle the demands of a huge population. By providing an accurate status check, consumption analyses can predict, with the use of population and production yield numbers, how much land area is going to be needed to supply the needs of a certain society. With this information we can plan for the future so as to work towards implementing sustainable development before we tap all of the world's resources dry.

Consumption Analysis of Hong Kong and Guangzhou

There is a need to study urban areas such as Guangzhou and Hong Kong because they consume many resources. Furthermore, much of the Hong Kong's industry has been shifted to the southern region of Guangdong Province mainly due to the availability of cheap labor and less stringent pollution regulations. As Guangdong continues to change, we hope that studies like this will play a part in helping sustainability become a greater focus of development planning in the Pearl River Delta region as a whole by demonstrating the interactions between Hong Kong and Guangzhou, with respect to resource consumption.

The Civic Exchange, the sponsor of this project, is interested in finding alternative resources and methods that are more sustainable to reduce the impact that Hong Kong and Guangzhou are having on the environment, especially since Hong Kong gets a large amount of resources from southern Guangdong and Hong Kong's investment capital is one of the main promoters of development in Guangdong. With new ways to reduce human environmental impacts, the Civic Exchange also hopes to find cheaper ways for Hong Kong to sustain itself, thus benefiting the economy as well.

As shown by Koenig, Warren, and Friends of the Earth (Koenig and Warren, 1997, FOE, 2001), ecological footprints and consumption analyses are important tools for assessing the current state of resource consumption versus sustainability of natural resources. The consumption data we gathered have been divided into five separate categories: food, water, materials, energy and urban biomass. Research was carried out on all five of these categories as well as on sustainability, economic trends linking Hong Kong and Guangzhou and various ecological footprint and consumption analysis formats. The information collected for our analysis is used to discuss the flaws and benefits of

Consumption Analysis of Hong Kong and Guangzhou

various ecological footprint and consumption analysis methods, to quantify accurately resource consumption in Hong Kong and Guangzhou and to provide information on Hong Kong's emerging sustainability policies.

CHAPTER II BACKGROUND AND LITERATURE REVIEW

2.1 Resource Consumption

Individuals, cities, and countries all have an impact on the Earth by consuming the resources it provides (Wackernagel, et al., 1997). This ecological impact can be defined as “the amount of nature they occupy to keep them going” (Wackernagel, et al., 1997, p. 4). One way to measure the ecological impact is to create an ecological footprint. To calculate the ecological footprint of a country it is crucial to assess the areas necessary to produce the resources needed to support that population.

Ecological footprints involve two main steps. The first step is an assessment of the resources consumed (consumption analysis). The second step is to translate the consumption analysis into a specific surface area. In other words, ecological footprints and consumption analyses “show us how much nature nations use” (Wackernagel, et al., 1997, p. 4).

It is important to note that the calculated surface area is not necessarily a continuous piece of land. One of the main reasons for this is international trade. A given nation may utilize resources from the entire world and thus may affect the world ecological system.

There are four methods to represent the data collected from consumption and waste (in some cases) analyses.

Consumption Analysis of Hong Kong and Guangzhou

2.1.1 Koenig and Warren's Method

The first method was developed by Koenig and Warren of the University of Hong Kong (Koenig and Warren, 2000). Their study involved a brief estimate of the surface area utilized by a region or country in order to sustain itself. Koenig and Warren's environmental analysis of Hong Kong was based on an in-depth consumption analysis that related Hong Kong's natural resource consumption analysis to those of other countries. The study was divided into many categories including water, materials, urban biomass, energy, and food. An environmental analysis can only be meaningful if it relates the area studied to the world ecosystem. The data that Koenig and Warren used were expressed in kilograms per capita. By presenting the data as per capita numbers, the data showed what was actually consumed by the population living in that region.

2.1.2 Friends of the Earth Method

The second method is represented by the Friends of the Earth's ecological footprint analysis of Hong Kong (FoE, 2000). As in Koenig and Warren's study, Hong Kong's consumption numbers were expressed in kilograms per capita. But in his study for Friends of the Earth, Walker compared Hong Kong's consumption data to fair share consumption numbers. "A fair share means dividing the natural limits of resource use equally among [all] people" (FoE, 2000, p. 12). The fair share concept takes into account the global nature of the economy. It takes into account international trade by tracking the resources used in a specific region that were imported, hence tracking the impact on the area where the resources originated. All the resources a specific region uses are calculated into a number that represents the impact of that region on the world as a

Consumption Analysis of Hong Kong and Guangzhou

whole. The fair share number for the world is then calculated by taking resources and dividing their mass or quantity by the world population. This analysis assumes that everyone will consume an equal share of resources. By comparing a specific region's calculated resource consumption to the fair share number, the region's impact on the world can be quantified. If a region's population has a larger resource consumption number than the fair share number, they are consuming too many resources and potentially harming the balance of nature. This method makes it easier to see how the supply of resources is being distributed around the world. In the conclusion section of this ecological footprint analysis, Walker provided numerous ecologically inclined sustainability measures that dealt with problems in all fields of the consumption analysis. These were brought together to propose a plan for an ideal "Ecocity."

2.1.3 Wackernagel's Method

Wackernagel came up with the third format we have studied as presented in Ecological Footprint of Nations (Wackernagel, et al., 1997). He conducted a footprint analysis of 52 of the most developed countries in the world. His footprint format was based on a consumption analysis in which he identified ecological comparison parameters by which all countries were compared. Production yields were averaged for all countries and used to calculate the utilized surface areas for each country.

2.1.4 World Wildlife Fund Method

The fourth format is the World Wildlife Fund's (WWF) *Living Planet Report* (World Wildlife Fund, 1999). This report was an attempt by the WWF to show

Consumption Analysis of Hong Kong and Guangzhou

quantitatively how much nature the Earth is losing. It also attempted to quantify how much pressure humans are putting on Earth. The report used the LPI or Living Planet Index, which measures the areas of the forests and species populations of fresh and sea water animals, essentially measuring the natural wealth of Earth. It was the goal of the report to show how the LPI has been changing over time.

The World Wildlife Fund's *Living Planet Report* looked at six causes of environmental change (World Wildlife Fund, 1999). These causes ranged from consumption of resources to the consequences of consuming these resources. In essence, the *Living Planet Report* related the consumption of resources, such as food, and how they are consumed to the impacts that this consumption has on the environment. The report took data from 151 countries and territories in order to create an overall LPI. The Living Planet Index quantifies the world's ecology by measuring three different parts of the world ecosystem: area of natural forests, populations of freshwater species and populations of marine species. Unlike forests, measuring area for water ecosystems is not indicative of changes in biodiversity. A more appropriate measure is the Freshwater Ecosystem Index and the Marine Ecosystem Index. These indexes include all vertebrate species for which there are time-series population data.

The World Wildlife Fund also measured consumption of grain, fish and wood. They looked at the consumption of these commodities because they are renewable resources which are essential to our way of life. Although a large part of this report does not deal with consumption, it gives an arguably more detailed view of the status of the world ecosystem because it tries to take into account all inhabitants of the earth.

2.1.5 Limitations of Ecological Footprints

There are limitations to an ecological footprint. Footprints are designed to show the impact of humans on the ecology of the world. In an effort not to exaggerate this impact there are uses of resources that remain uncounted. An ecological footprint study limited to one country or region will not measure direct ecological impacts shifted to other regions of the world due to trade and direct foreign investment.

Ecological footprints are not representative of the quality of life and only represent resources consumed. Often the consumption patterns vary within a country. Theoretically speaking, in terms of establishing causality between resource consumption and its ecological impacts, it is not very telling to average out the consumption habits of many different people and directly correlate them to ecological problems. In certain cases where consumption and external factors (such as weather patterns, for instance) are somewhat more homogenous, an ecological footprint will be more representative. But this is not often the case.

Another limitation is the way ecological footprints count certain resources. As Wackernagel states about fresh water in his study Ecological Footprint of Nations (Wackernagel, 2000, p. 6):

“Particularly in dry countries, fresh water becomes a critical resource that should be covered by footprint assessments. There, human settlements, agriculture and other ecosystems compete for this use of nature. Furthermore, water is diverted for human uses, at high-energy costs and often with significant ecological impacts. Also the ecological impacts of contamination are only marginally included in current assessments.”

This is one example that shows us that there is often some portion of the ecology missing from the ecological footprint. Footprints only represent the renewable portion of

Consumption Analysis of Hong Kong and Guangzhou

resource consumption. There are many by-products of resources and synthetic materials used in the world that are unable to be counted in a footprint, thereby discounting a huge factor in the actual ecology of Earth.

Finally, there is no standardized format for calculating ecological footprints. As one can see, there are various methods of calculating ecological footprints that stem from the complex and abstract nature of the conversion from resource consumption to land area. Therefore, results for a given region may vary according to what footprint format is used. It consequently becomes extremely challenging to compare the ecological footprints of different regions that have been completed using different methods.

2.1.6 Advantages of Ecological Footprints

There are many advantages to an ecological footprint (Wackernagel, 2000). An ecological footprint can be used to determine the resource consumption of a given nation and compare that to the resource consumption of other nations calculated in the same format. This is a great tool in developing conservation policy and economic policy because it provides data on how current actions affect the planet. The ecological footprint is also useful in that the data can show nations where they are taking too much of a resource and where they are using resources in a relatively sustainable manner. In looking at sustainability, ecological footprint studies can serve as a measuring stick in evaluating how a population's ecological footprint compares to nature's carrying capacity (Hong Kong Planning Department, 2002).

2.2 Sustainability

The Bruntland Commission defined sustainable development as “a development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Dubois-Taine & Henriot, 2001, pg. 19). Although this definition may seem broad, the determination of a plan of action to attain sustainability must always assess sociological, economic, environmental and cultural needs of a population. In order to guide this population towards sustainability, these needs must be tied into management and finance layered with both long-term and short-term goals.

2.2.1 Hong Kong’s Development

Hong Kong began to develop as many other Asian cities have with retailing, manufacturing and the textile industry, storage, and residential functions all mixed together (Dubois-Taine & Henriot, 2001). The shores of the harbor were first to develop. Lower and middle class living areas were intertwined, and upper class housing accumulated in clusters among these living areas. Population grew rapidly, and in order to cater to this, the government began a plan to build up new urban clusters around the city in order to provide living space and industrial job opportunities for the growing population.

Ideally this was supposed to prevent over-congestion around the well developed shores. This was especially necessary since the industrial and vibrant areas around the shores already had a relatively high level of congestion due to their proximity to and interaction with residential functions (Dubois-Taine & Henriot, 2001). In retrospect, it seems that this may have been a naïve way of promoting economic growth as well as

Consumption Analysis of Hong Kong and Guangzhou

supplemental housing. The government did not fully take into account the high cost necessary to put in place adequate commuting resources as well as enough of a demand to live at a distance from the shores of the harbor. Hong Kong experienced an unmistakable shift from a uni-centric pattern with peripheral extensions to a multinuclear pattern of urban development. In summary, the Hong Kong government had two goals motivating this plan of action.

The first goal was to provide a rapidly growing population with decent housing in order to achieve social stability and political popularity while allowing room for the city of Hong Kong to grow demographically and economically (Dubois-Taine & Henriot, 2001). Due to Hong Kong's not so easily developable land area and the indigenous residents' of the New Territories unwillingness to accept government compensation for land "take-overs," the cost of land development in Hong Kong rapidly rose and happened in the form of high density high rises as opposed to urban sprawl.

The second was to provide cheap land for economic activities in order to move industrial operations away from the shores (Dubois-Taine & Henriot, 2001). Development of industry in Hong Kong fell short of expectations due to the cheap labor and land available in China, as well as the inconvenience involved in moving goods from northern Kowloon to the shores of the harbor. Nevertheless, in coordination with these social and political motivations the housing programs brought about economic development. During the nineteen sixties, seventies, and eighties, Hong Kong adopted and experienced an export-led economic growth through the development of a manufacturing industry. This was further enabled because of the inexpensive public housing, which helped keep wages low and reduced social mobility among the working

class. People were forced to get any job in their immediate area, which in most cases involved some sort of job in the manufacturing sector.

Since the mid-nineteen eighties, the finance, service, and tourism sectors have experienced significant growth (Dubois-Taine & Henriot, 2001). Combined with the beginning of the shift of Hong Kong's manufacturing sector to China, Hong Kong began to experience a renewal of the importance of the Central business district on Hong Kong Island. Similar to when Hong Kong was first colonized, an emphasis was put on Hong Kong's hub function as well as being an international center in Southeast Asia. The Hong Kong government began to show some concern about environmental conditions. Community response also voiced a concern for poor air quality, a need for environmental education and sustainability.

2.2.2 Sustainability in Hong Kong

In 1985, the Planning and Standards Department was the first to include a written environmental guideline regarding urban development. This required that all major public housing developments undergo an environmental impact assessment study.

In 1989, further environmental concerns were addressed with the White Paper on 'Pollution in Hong Kong – A Time to Act'. The paper stated, "Serious environmental pollution in Hong Kong is an unfortunate by-product of economic success and population growth. One of the government's major priorities is halting the decline in environmental conditions and to do more to improve our environment" (Dubois-Taine & Henriot, 2001, p. 3). The paper provided a structure for a ten year plan to reduce ecological impacts with reviews of progress every other year.

Consumption Analysis of Hong Kong and Guangzhou

In 1997, before the end of the “White Paper plan,” the Hong Kong government commissioned a study on “Sustainable Development for the 21st Century.” This included guidelines on “the sustainability quality of the local environment for residential development [...], the compatibility of the proposed project with existing land uses and infrastructure, the impact of the proposed development on the environment both during construction process and after completion [...], mitigation measures against undesirable environmental impact, and the planning gains to the locality in environmental terms” (Dubois-Taine & Henriot, 2001, p.105).

In 1998, the proposal of two reclamation projects was made public. These were intended to make land available for economic activities and additional public housing. However, the public showed its strong disapproval. The public was supposed to be involved in the decision making process through the Town Planning Board. Various professionals from different parts of the business sector dominated the board. Because of this, the decision-making actually involved the view of relatively wealthy businessmen instead of the general public. There can clearly be a difference in interest between the wants of the upper class and the wants of the lower and middle classes. In this system it seemed that the interaction between the Town Planning Board and the public was more of a burden than a tool and was only facilitated when it was absolutely necessary.

The public demanded a more cooperative method of policy making. In the Planning Department’s annual report, a modified policy making process was proposed. This entailed including the public in the methodology planning and other early stages of the decision making process. Furthermore, people who were anticipated to be affected by any new decisions (i.e. stakeholders, target groups, etc...) were encouraged to voice their

opinions in public consultation forums and other meetings. Also, comprehensive technical reports were made accessible. Public involvement has thus significantly increased over the past three years.

2.3 Consumption Analysis of Hong Kong

By using Friends of the Earth's data in conjunction with Koenig and Warren's data, we were able to establish guidelines for our consumption analysis which included the following categories: food and nutrients, water, materials, energy and urban biomass.

2.3.1 Food and Nutrients

The inhabitants of Hong Kong enjoy one of the most "westernized" diets of all of East Asia. This diet consists of larger portions with higher protein and fat intake than in other Asian countries (Koenig and Warren, 2000). From 1971 to 1997, food consumption for the average person in Hong Kong went up 52% from 1.22 kg to 1.86 kg of food consumed daily. In Hong Kong, the daily diet consisted of 16% meat, 16% fruits and vegetables, 9% rice, 9% fish and other seafood, and the remaining 50% under the category of 'other foods' (Koenig and Warren's study does not explain what the category 'other foods' contains). The average person also consumes 20 grams of nitrogen and 20 grams of phosphorous per day (see Tables 1 and 2).

Consumption Analysis of Hong Kong and Guangzhou

Table 1 - Comparison of per capita food supply, daily per capita calories, protein, and fat for various countries in 1997 (Koenig and Warren, 2000, p. 5)

	Daily per capita calories kcal/day	Food Supply kg/year	Protein (g/day)	Fat (g/day)
Hong Kong	3204	678.8	98	133.4
China	2897	612.1	77.9	70.8
Japan	2932	679.2	96.2	83.1
Indonesia	2886	448.2	66.5	53.6
Thailand	2360	475.5	53.6	46.8
Germany	3379	975.8	95.7	144.4
US	3699	1054.7	112.3	142.8

Hong Kong people's diet included almost as many calories, protein and fat as those in Germany and the United States (Koenig and Warren, 2000.).

This diet has had effects on Hong Kong's population as well as its natural environment (Koenig and Warren, 2000). Higher fat and protein intake have contributed to increased cases of obesity in Hong Kong as well as an increase in the average person's height. Furthermore, because of an increase in population and a need for land area, Hong Kong has decreased its land area devoted to agricultural production. Animal husbandry has also decreased. Hong Kong gets a majority of its meat from mainland China. Therefore, while local waste due to animal husbandry has decreased Hong Kong it has simply increased its ecological footprint and shifted the environmental problems elsewhere.

Consumption Analysis of Hong Kong and Guangzhou

Table 2 - Food and nutrient consumption in Hong Kong, kg/capita per year (Koenig and Warren, 2000, p. 6)

	1971				1997			
	Per capita consumption		Protein	Fat	Per capita consumption		Protein	fat
	kg	calories	(g/ca day)	(g/ca day)	kg	calories	(g/day)	(g/day)
Cereals	145	1250	25.4	3	111	958	19.1	2.3
Starchy roots	20.7	44	0.4	0.1	33.1	57	0.3	0
Sugar crops	0	0	0	0	0.1	0	0.1	0
Sweetners	18	172	0	0.1	40.9	369	0	0.1
Pulses	3.1	25	1.6	0.1	1.6	14	0.9	0.1
Treenuts	1.5	13	0.2	1.3	3.5	28	0.7	2.5
Oil Crops	6.6	68	4.4	4	5.7	64	3.9	4.1
Vegetable oils	12.5	303	0	34.3	18.6	451	0.1	51.1
Vegetables	87	185	5.2	1	40.6	42	1.8	0.3
Fruit	69.8	72	0.9	0.4	106	96	1.3	0.6
Stimulants	2.2	9	0.6	0.6	2.5	12	0.5	0.9
Spices	0.4	4	0.1	0.2	1.9	18	0.6	0.6
Alcoholic beverages	20.7	52	0.2	0	32.2	55	0.4	0
Meat	68.1	405	21.2	34.8	110	517	34	41
Offals	8.5	26	4.3	0.7	18.3	56	9.2	1.6
Animal fats	5.5	110	0	12.2	8.6	173	0.1	19.3
Milk	29.9	58	2.9	1.3	72.4	128	6.4	4.6
Eggs	12	48	3.8	3.4	12.3	49	3.9	3.4
Seafood	5.5	91	14.9	2.7	57.8	105	17.1	2.9
Aquatic products	0.5	0	0	0	0.6	0	0	0.1
Misc.	0	11	0.4	0.1	0	13	0.4	0.2
Total	567	2946	86.5	100.3	678	3205	100.8	135.7

Agenda 2047 of Friends of the Earth calculated a similar reduction in Hong Kong food production as seen in the “Hong Kong food footprint graph” (FoE, 2000, p.19). This graph shows that Hong Kong focuses 85% of its food production on fish and other seafood (see Figure 1). Friends of the Earth’s analysis agrees with Koenig in saying that Hong Kong is shifting away from agricultural production and land-based animal husbandry.

Consumption Analysis of Hong Kong and Guangzhou

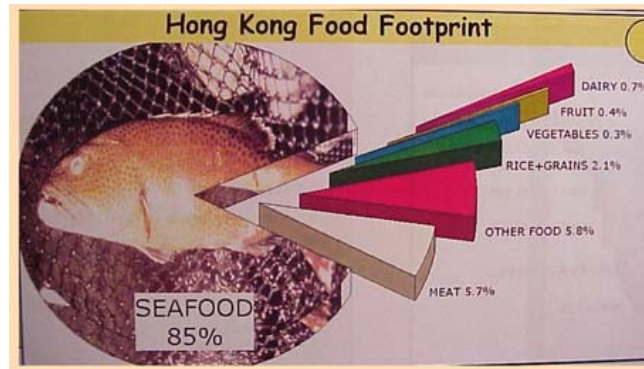


Figure 1. The breakdown of Hong Kong's food appropriation (FoE, 2000, p. 19)

2.3.2 Water

An abundant water supply is essential to a growing city such as Hong Kong. In order to monitor the water ecological footprint, it is important to monitor volumes of water withdrawn from the environment rather than volumes of water used (FoE, 2000). Since water can be recycled, it is nearly impossible to keep track of the water ecological footprint. Having a record of water withdrawn from the environment can serve as a basis for calculating the efficiency of water use. From 1971 to 1997, the demand for fresh water per capita increased from 272 liters per day to 379 liters per day (Koenig and Warren, 2000). However, the yearly rate of increase of Hong Kong's water use has declined from approximately 10% in the 1970's to 2% in the 1990's. Overall, the distribution of water use can be divided into the following: domestic water usage consumes 45%; industry uses 3%; commercial uses make up 25%; and 17% falls under miscellaneous uses of water. Agenda 2047 (FoE, 2000) divides the percentages of water use differently. According to that study, Hong Kong uses 27% of its water for cotton and paper production, 15% for rice and oil, 10% for meat, 10% on other foods, 19% on

Consumption Analysis of Hong Kong and Guangzhou

energy, 7% on construction material, 4% on other materials, 2% on plastics production, and only 6% on direct water use (i.e. personal use).

Hong Kong gets its fresh water from two main sources: rainfall and Guangdong Province. It rained an average of 2,214 mm yearly from 1990 to 1995 (Koenig and Warren, 2000). However, recently, Hong Kong's natural rainfall has increased to over 3,346 mm yearly (in 1997). In order to guarantee a consistent flow of water for its population, Hong Kong receives approximately 76% of its fresh water from Guangdong. In 1997, Hong Kong received 698 million cubic meters of water out of 913 million cubic meters of water from Guangdong, while Hong Kong's own reservoirs were able to catch 224 million cubic meters of clean fresh water. There was a discrepancy of 9 million cubic meters of water between what Hong Kong was documented to receive and what was actually received. Reasons for this discrepancy are loss during transmission and inaccurate measurements and erroneous data.

In addition to fresh water, Hong Kong uses seawater in order to service some plumbing in living areas, commercial buildings, and at power stations and commercial buildings (Koenig and Warren, 2000). In 1997, 198 million cubic meters of seawater were used for toilet flushing, while power stations and commercial buildings used approximately 9,125 million cubic meters of seawater for cooling purposes (see Table 3).

Hong Kong now loses 36% of its main fresh water supply due to leakage in pipes (Koenig and Warren, 2000). This amount has gone up from 23% in 1971. Very little work has been done to maintain the water pipes, which can account for this significant increase in water loss (see Table 3).

Consumption Analysis of Hong Kong and Guangzhou

Table 3 - Water consumption in Hong Kong in 1971 and 1997 given in million cubic meters per year (A) and in liters per capita per day (B) (Koenig and Warren, 2000, p. 7)

	Domestic		Commercial and municipal		Industry and power generation		Agriculture		Other		TOTAL	
	1971	1997	1971	1997	1971	1997	1971	1997	1971	1997	1971	1997
Fresh Water												
A*	133	419	60	268	43	120	154	?	0	106	390	913
B**	93	174	42	111	30	50	107	?	0	44	272	379
Salt water												
A*	62	198	200	?	1040	9125	0	0	0	0	1302	9323
B**	43	82	139	?	723	3778	0	0	0	0	905	3860

*units in million cubic meters per year

**units in liters per capita per day

In 1978, water conservation measures were suggested as it was foreseen that a growing city such as Hong Kong would need a significant amount of fresh water (Koenig and Warren, 2000). However, these suggestions were ignored, and instead, contracts were made with Guangdong to supply fresh water starting in 1989. The Dong Jiang River from which Guangdong supplies freshwater to Hong Kong has become polluted with high nitrogen levels hydro chemicals. Ironically, rainfall has recently increased in Hong Kong, and instead of being able to use the cleaner rainfall water, Hong Kong has had to dump the rainwater and, due to contractual agreements, continue to use Guangdong's increasingly polluted river water.

2.3.3 Energy

In 1997, Hong Kong consumed 472,439 TeraJoules of energy (Koenig and Warren, 2000). This is equivalent to 12.4 million tonnes of oil or only 8.2% of the yearly solar radiation over Hong Kong. In 1997, Hong Kong's energy supply was taken entirely

Consumption Analysis of Hong Kong and Guangzhou

from outside sources (Koenig and Warren, 2000). Coal used by the power sector makes up 31% of Hong Kong's Primary Energy Supply (PES). Oil products such as gasoline, diesel and LPG as well as natural gas are used for transportation and domestic uses. Hong Kong classifies natural gas as an oil product. These oil products account for the remainder of Hong Kong's PES. Hong Kong's commercial and residential structures use up approximately 60% of the PES, industry uses up 16% and local transportation uses about 24%. Transportation of energy producing materials and the energy used in other international transportation consume an additional 140,300 TeraJoules of fossil fuels annually (see Table 4).

Similar to water distribution, Hong Kong wastes significant amounts of energy (Koenig and Warren, 2000). One reason for this is the conversion of primary energies to secondary energies such as the use of coal to generate electricity. The process used by Hong Kong to generate electricity from coal is inefficient, thereby creating more waste than necessary. One reason for this inefficiency could be that the coal plants are old and out of date; however, it was not discussed in Koenig and Warren's (2000) study. It is also difficult to gather data on the actual production plants themselves.

Table 4 - Energy in Hong Kong, 1971 and 1997 (Koenig and Warren, 2000, p. 8)

1971					
Fuel Type	Domestic	Commercial	Industrial	Local Transport	Total
Solid	840	490	1094	0	2424
Liquid (inc LPG)	8134	9716	14788	21611	54249
Electricity	4278	6399	7279	56	18012
Town gas	541	385	93	0	1019
Final Energy Supply	13793	16990	23254	21667	75704

Consumption Analysis of Hong Kong and Guangzhou

Conversion losses	11946	17418	19519	146	49029
TOTAL (PES)	25739	34408	42773	21813	124733
tJ/capita year	0.007	0.009	0.011	0.006	0.032
mJ/capita day	18	24	30	15	87

1997

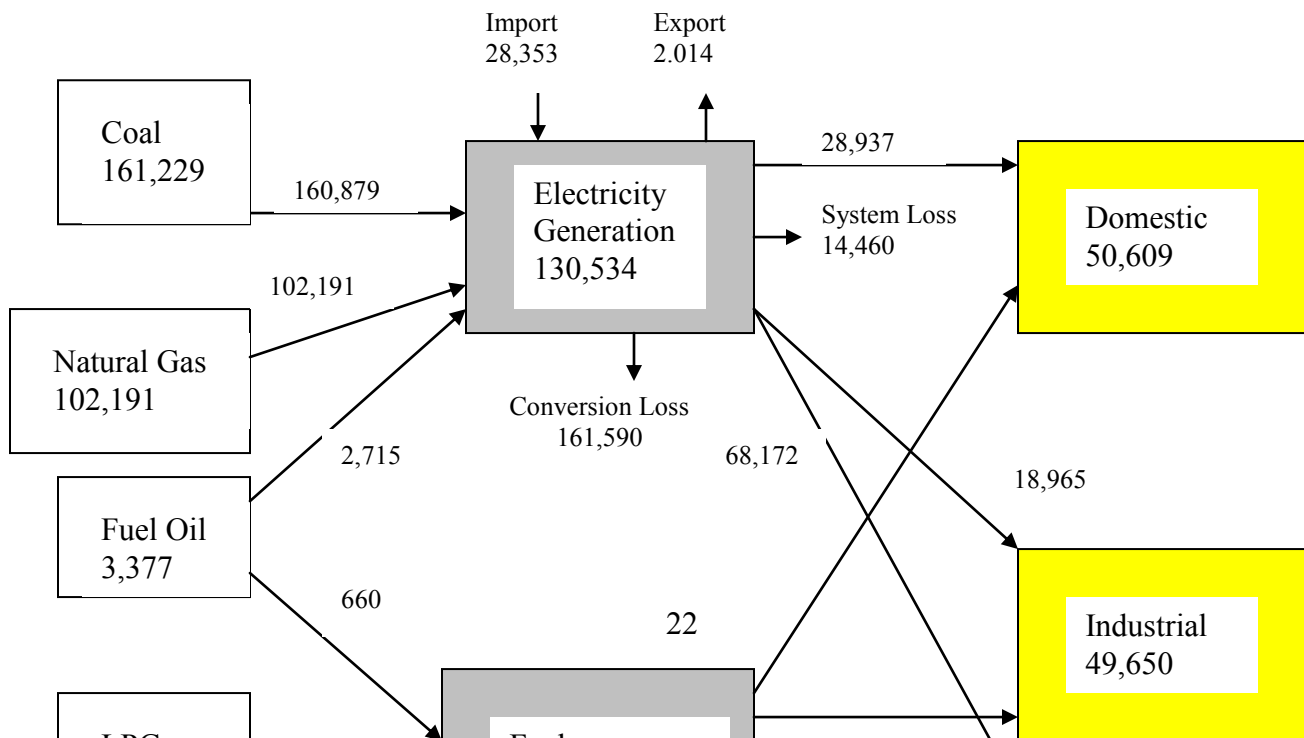
Fuel Type	Domestic	Commercial	Industrial	Local Transport	Total
Solid	87	206	57	0	350
Liquid (inc LPG)	3564	3197	33861	113334	153956
Electricity	28937	68172	18965	0	116074
Town gas	12465	10529	911	0	23906
Final Energy Supply	45054	82104	53794	113334	294286
Conversion losses	44986	104323	28844	0	178153
TOTAL (PES)	90040	186427	82638	113334	472439
tJ/capita year	0.014	0.028	0.012	0.017	0.071
mJ/capita day	37	77	34	47	196

Another reason for inefficiency is during the transmission of power to end use sites, and the final reason for energy loss is due to inefficient lighting and appliances at end use sites. In 1997, 2,103 TeraJoules of energy were lost during gas manufacturing, 161,590 TeraJoules during electricity generation, 14,460 TeraJoules from power system losses, 178,153 TeraJoules for total conversion losses, leaving approximately 294,286 for final energy use. This is a dramatic increase from 1971 energy numbers, when transmission losses amounted to 49,029 TeraJoules and final energy use was 75,704 TeraJoules (see Figure 2).

Since 1971 inputs of energy have clearly increased (Koenig and Warren, 2000). Solid fuels have gone from 193 tonnes per day to 17,185 tonnes per day, and liquid fuels have risen from 11,030 tonnes per day to 19,006 tonnes per day. Hong Kong has noticed an increasing rate of change in per capita fossil fuel use. This reflects the growing economic development as well as heightened standards of living and comfort in homes.

Consumption Analysis of Hong Kong and Guangzhou

During the 1990's, the PES proportions began to shift (Koenig and Warren, 2000). Coal was progressively replaced by natural gas to cut down on pollution, and low quality, high sulfur coals were substituted with high quality, low sulfur coals. Low sulfur coals are naturally denser than high sulfur coals and burn more efficiently than high sulfur coals. This is because there are fewer impurities in the coal, which results in cleaner and more efficient burning. Since the creation of the Daya Bay nuclear power plant in 1993 in Guangdong, Hong Kong has imported a growing percentage of electricity from China. By 1996, less than 50% of Hong Kong's energy was generated from coal, 20% was generated from nuclear power from China and 30% came from natural gas. It is theorized that Hong Kong could offset its carbon dioxide production due to energy manufacturing by planting 137,000 square kilometers of trees (FoE, 2000). However, if all the countries in the world adopted this approach, over 26% of the Earth's land would have to be re-forested which is unrealistic.



2.3.4 Materials

Recently Hong Kong has experienced a new trend in material use. Due to modernization, Hong Kong's use of wood and paper has decreased significantly, and its use of plastics and glass has concurrently increased. Agenda 2047 does not take into account plastics, glass and other synthetic materials in its study of the raw material footprint (FoE, 2000). However, in the overall material footprint, the study does take into account synthetic materials. The average person living in Hong Kong uses approximately 7,000 kilograms of materials per year and disposes of about 2,000 kilograms of waste (Koenig and Warren, 2000). Since 1971, plastic consumption has risen by 400%. Also, 34% of the plastics used became waste, and 66% of glass used was thrown out. A significant amount of Styrofoam, food and other solid materials annually contributes to Hong Kong's waste. Every day 120 tonnes of Styrofoam are deposited in landfills. Since 1971, the amount of perishable material (not synthetic material; i.e. food and other material capable of rotting) in waste has increased by 530%. Relatively speaking, Hong Kong consumes a below average amount of materials. This can be attributed to dense land development, which leads to less material consumption than urban sprawl. The average amount of materials required to construct and furnish densely populated habitations is less than the amount required to construct and furnish dispersed living areas.

2.3.5 Urban Area

The urban area ecological footprint deals with area allotted to urbanization such as habitation, roads, and building structures. Being so densely populated, Hong Kong has

Consumption Analysis of Hong Kong and Guangzhou

a small urban area ecological footprint since each person takes up less land than in most other cities and countries (FoE, 2000, p.20). The urban area footprint can be divided into the following: 83% for urban area, 3.9% for roads, 3.8% for water supply, 3.7% for power and fuel, 3.4% for iron and steel, 1% for copper, 0.8 % for golf courses, 0.4% for rock quarry, and 0.1% for aluminum.

2.4 Interactions between Guangdong and Hong Kong

Hong Kong has one of the highest population densities in the world with 6.8 million people and 61,000 people per km² in 1997 (Koenig & Warren, 1997). Because of Hong Kong's population density the city is not able to support itself alone and depends heavily on outside ecosystems to provide resources. Large portions of these resources are obtained from neighboring Guangdong Province. Hong Kong impacts Guangdong by appropriating food, water, energy and material goods as well as indirectly with waste discharge.

2.4.1 Appropriated Land from Guangdong

The ecological area that was used by Hong Kong in 1997 was estimated as being 247,264 km² to 393,506 km², which included land (both inside and outside of Hong Kong) for agriculture, forests and marine areas. In the study done by Koenig and Warren (1997), it was reported that 188,365 km² of outside area was used by Hong Kong for food, seafood, fiber and paper, where almost 28% of this amount came from Guangdong.

Consumption Analysis of Hong Kong and Guangzhou

2.4.2 Food Provided by Guangdong to Hong Kong

Hong Kong produces almost none of its own food. Therefore, a large percent of its ecological footprint is due to food consumption. In 1998, Guangdong was estimated to supply Hong Kong with 60% of its fresh vegetables, 27% of its live poultry, 81% of its live pigs and almost a 100% of its live cattle and freshwater fish. Hong Kong uses a total food area of 55,232 km² from Guangdong, where 51,628 km² of that area is marine area used for fish and other seafood production (Koenig and Warren, 1997).

2.4.3 The Impact of Food Production for Hong Kong in Guangdong

In feeding the population of Hong Kong, a large amount of nitrogen waste is produced in Guangdong. As stated by the U.S. Environmental Protection Agency (USEPA 2001), nitrous oxides make up 12% of the greenhouse gas produced from fertilizers used for agriculture (Gardner and Stern, 1996). Table 5 shows the nitrogen discharge from Hong Kong and Guangdong that was produced from the livestock, fish and seafood that were consumed by the Hong Kong population. In 1997, Guangdong produced 38,025 tonnes of nitrogen waste to produce Hong Kong's food. Also 12% of the nitrogen discharge produced outside Hong Kong was made by fishponds in Guangdong (Koenig and Warren, 1997).

Consumption Analysis of Hong Kong and Guangzhou

Table 5 - N-discharges and water appropriation in various locations for food, water and fiber consumption in Hong Kong, 1997 (Koenig and Warren, 1997)

Category	N-discharges in Hong Kong (tonnes N/yr)	N-discharges in Guangdong (tonnes N/yr)	N-discharges in rest of world (tonnes N/yr)	Total N-discharges from HK (tonnes N/yr)	Water from Guangdong (1×10^6 m ³ water/yr)
Livestock Production	2,255	33,825	47,450	83,530	1,306
Beer	5	10,832	8213	19,050	303
Chicken	728	9,820	30112	40,660	344
Pork	1,522	13,173	9125	23,820	659
Fish and seafood	1,273	4,200	9,873	15,346	420-1260
Grains, vegetables and fruits production	-	-	-	-	278
Fiber	-	-	-	-	330
Domestic sewage	48,305	-	-	48,305	-
Total	51,833	38,025	57,323	147,181	2,334

2.4.4 Drinking Water and Water Used for Food Production

Starting in 1960 Guangdong supplied Hong Kong with 22.7 million m³ of water yearly. Since then the water supply from Guangdong has increased reaching 720 million m³ in 1996. Hong Kong is currently receiving over 70% of its fresh water supply from the Dong Jiang River in Guangdong. Also 2,334 million m³ of water was used by Guangdong for livestock, poultry, vegetables, farm fish and other products that were exported to Hong Kong (Koenig and Warren, 1997).

2.5 Conclusion

Ecological footprints come in various forms and can be calculated in a number of different ways. It is important to determine the goals of the urban area of completing the study in order to determine which format would be best for the locale. After studying the situation and the various ecological footprints of Hong Kong, we have decided that a

Consumption Analysis of Hong Kong and Guangzhou

consumption analysis like that done by Koenig would be the best-suited method for our study.

CHAPTER III METHODOLOGY

3.1 Introduction

A detailed format for completing this study was essential to obtaining accurate results. The following section describes how our team completed this project. The methods described below were implemented to gather, assess and present the data pertinent to the completion of this study.

3.2 Project Focus

One of the main problems we encountered in putting together a meaningful consumption analysis was retrieving accurate data. For example, various departments in the Hong Kong SAR government make adjustments to data, ignore small trade value declarations (small trade declarations have a value of under HK\$10,000) and marine fish arriving directly from fishing grounds or crafts registered or licensed in Hong Kong, do not account for any trade directly related to the government or armed forces, and do not track the resource consumption involved in traveling during trade (Census and Statistics Department, 2000). It was thus indisputable that a consumption analysis would be an approximation. However, the completion of an ecological footprint involved even more of a percent error since it took approximated consumption numbers and applied them to calculations with numbers that already have a percent error (production yields, for instance). We have focused on a consumption analysis of Hong Kong and Guangzhou in order to provide a more accurate report on consumption trends.

Consumption Analysis of Hong Kong and Guangzhou

Initially the project was focused on analyzing the consumption of Hong Kong and Guangdong Province. After researching both areas, we realized an accurate comparison could not be made. Guangdong has a much greater population, a larger land mass and uses many more natural resources than Hong Kong. Because Guangdong is a relatively large province, its standard of living changes drastically from the industrialized cities in the Pearl River Delta to other more rural areas. In order to complete a more meaningful study, we chose to compare Hong Kong to Guangzhou, the capital city of Guangdong. Both cities are major trading ports and have similar populations. However, Hong Kong has a service based economy, whereas Guangzhou has a more industrial base. Hong Kong produces few resources and thus is very dependent on the Pearl River Delta area of which Guangzhou is a part.

Regardless of the discrepancies in data, a consumption analysis serves as an approximation of resource consumption. Consumption analysis data serve to call attention to consumption patterns. Once these consumption patterns are analyzed, it is also important to identify production techniques and waste generation which occur as a result of both production and consumption. Production, consumption and waste generation all contribute to the overall sustainability of a region. It is important to identify the measures a specific region takes to approach sustainability. However, sustainability cannot be achieved solely by a given region due to the interconnectivity of regions, economies, and ecosystems. Ideally, the study of a region's sustainability should encompass the entire world.

3.3 Interviews

Our group utilized interviews to obtain information needed to form a basis for our consumption analysis. Interviews with: an ecologist, an economist, people from Hong Kong SAR government offices, and a professor at the University of Hong Kong were conducted.

Specifically, we looked for information on: sustainability; economic trends between Hong Kong and Guangzhou; and consumption of energy, water, food, materials, and urban biomass for Hong Kong with relation to Guangdong and Guangzhou. From the interviews some feedback and advice on data interpretation were used to supplement our knowledge of how to present and interpret ecological information. Discussions on predictions and solutions for the consumption of resources and waste production in Hong Kong and Guangdong were part of our interview process.

We interviewed Professor Koenig from the University of Hong Kong, author of “Hong Kong’s Urban Metabolism and Ecological Footprint: 1971 – 2000” (Koenig and Warren, 2000), and Mr. Walker from Friends of the Earth, author of “Agenda 2047: Sustainability...A Community Dialogue” (FoE, 2000). Professor Koenig and Mr. Walker provided us with an accurate sense of what would be involved in putting together a consumption analysis and an ecological footprint. Furthermore, they helped us identify a better direction for our project by giving us the idea to incorporate the issues of sustainability into our consumption analysis.

We also interviewed Mr. Brown, an economist affiliated with Civic Exchange. Mr. Brown was helpful in pointing out various ways that the government in Hong Kong SAR is not efficient in dealing with sustainability. The information we collected helped

Consumption Analysis of Hong Kong and Guangzhou

us to make economic ties between Hong Kong's over-consumption and its economic policies.

The government offices we contacted were: the Agriculture, Fisheries and Conservation Department; the Planning Department; the Environmental Protection Department; Water Supplies Department; and the Census and Statistics Bureau. We contacted a representative from each of these offices to get current consumption data as well as a first-hand account of the environmental changes that have occurred since 1997. We also inquired about the sustainable development plans that each of these offices is considering for short-term and long-term action. These offices also supplied us information on energy, water, food, materials and urban biomass. The Census and Statistics Department also provided information on the effects of population growth since 1997.

We attended various conferences and meetings where Ms. Christine Loh was actively involved in the discussions regarding land development and sustainability. The conferences included a Shell Oil sponsored Forum on Pursuing a Sustainable Future and a meeting of the General Chamber of Commerce of Hong Kong where the economic impact of sustainable development as well as the decision making and dialogue processes between government offices and stakeholders were discussed.

3.3.1 Interview Protocol

Before arriving in Hong Kong, we had contacted Professor Koenig by email and introduced ourselves. Upon arriving in Hong Kong, with Ms. Christine Loh's assistance, we were able to set up additional interviews with all the desired contacts.

Consumption Analysis of Hong Kong and Guangzhou

For interviews we used a semi-structured interview protocol, which was based on prepared questions but also allowed for improvisational freedom (Bernard, 2001). The interview protocol contained a list of the questions and other topics that needed to be covered (See Appendix C). In addition to using our prepared open-ended questions, we asked questions on any new information that surfaced in the interview.

At each interview there were two students, one student operated a tape recorder and took notes and the other conducted the interview. We began with an introductory statement, which explained the project and what we were looking for. The interview protocol included throw-away questions, essential questions, and probing questions. The essential questions were concerned with the focus of the study. The throw-away questions were usually used at the beginning of the interview in order to make the interviewees feel comfortable and were not questions for gathering vital information. Our essential questions were aimed at getting data as well as guidance for interpreting our information. Lastly, probing questions were used to get the interviewee to elaborate on previously answered questions (Berg, 2001). At the close of the interview, we asked the interviewee if it would be possible for us to request another interview at a later date to answer any questions that might come up. A general interview protocol can be found in Appendix C.

3.3.2 Assessment of Interviews

We assessed each interview in order to extract the relevant data. This process included the transcription of detailed note taking of any interview that provided us with data for our project. While we went through this process, we looked for any resources

that had been mentioned that we had not previously checked, including books, web pages, possible interviewees, journals, etc. We then identified the vital information provided by the interviewee. This information was assessed for bias and cross-checked with other resources.

3.4 Archival Research

3.4.1 Gathering Data

Upon arriving in Hong Kong, we gathered data for the consumption analyses of Hong Kong and Guangzhou. This consisted of researching sustainability policies of various Hong Kong government departments, economic interactions between Hong Kong and Guangdong and year 2000 consumption data regarding energy, food, water, urban and material consumption in Hong Kong and Guangzhou.

By communicating with Professor Koenig, Mr. Walker, Mr. Brown and people working for the Civic Exchange, we gathered information on where to find such data. This led us to the Hong Kong University library, the Central library in Causeway Bay, and various government offices and web sites.

3.4.2 Data Analysis

We sorted our consumption data into the following categories: energy, food, water, urban biomass and materials. The structure we set up for our consumption analysis followed the structure set up for Hong Kong's consumption analysis in chapter two as well as the structure of various statistical government publications. For any gaps that we came across between Hong Kong and Guangzhou's consumption statistics, we

Consumption Analysis of Hong Kong and Guangzhou

used economic data such as trade trends in order to relate Hong Kong and Guangzhou in all resource consumption aspects of their interaction.

Once we sorted our data into the above categories, we assessed the data's validity and accuracy. This was done by identifying the source of the data and by looking at how they were recorded, analyzed, and released. Furthermore, when we found overlapping data, we compared and contrasted them. By recognizing potential bias, we were able to generate a more meaningful and accurate consumption analysis of Hong Kong and Guangzhou. It was also necessary to compare different sources of data from Guangzhou because, due to inaccurate translations from Chinese to English, some of the units for population density in Guangzhou were off by factors of 10. Because there were numerous instances where Guangzhou and Hong Kong data did not match up, we have discussed any "holes" in the data at the relevant places in Chapter IV.

3.4.3 Calculations

The consumption analyses of Hong Kong and Guangzhou were calculated by taking amounts produced, adding imports and subtracting exports and re-exports. Most of our calculations were not complicated in the sense that they involved adding up subcomponents of various sections in order to check our data. We also used calculations to obtain percentages of various consumption fields in order to come up with visual aids (e.g. tables, charts, figures, etc...).

The calculation we performed to convert numbers to per capita units was: the amount consumed divided by the end of year population of the area. The population figures we used for Hong Kong (whether or not we were converting to per capita units)

Consumption Analysis of Hong Kong and Guangzhou

were 6,156,000 in 1995 and 6,720,000 in 1999; the population figure we used for Guangzhou was 6,850,000 in 1999.

For the urban biomass, population densities were calculated by taking the total population and dividing that number by the inhabited land area.

In the energy section of the consumption analysis, there were problems in matching up the Hong Kong and Guangzhou data. We had planned on discussing primary energy requirements, energy conversions and end use.

Hong Kong provided all of its primary energy requirements in tJ, however Guangzhou did not provide these requirements. In order to quantify the appropriated energy resources prior to energy conversions for both cities, we presented retained imports (which is the difference between import and export quantities) as well as production and local provision. Unfortunately, Hong Kong expressed its retained imports of oil products in kiloliters (a unit of volume), and Guangzhou expressed its retained imports of oil products in tonnes (a unit of mass).

As shown in Table 6, we converted Hong Kong's retained imports of oil products from kiloliters to tonnes by multiplying the volume of Hong Kong's oil products with their density.

Table 6 - Oil product conversions (Environmental Technology Center, 2001)

		volume (kl)	approximated item	avg density	mass (tonnes)
Oil Products	aviation gasoline & kerosene	3,657,977.00	aviation gasoline 100, kerosene	0.762	2,787,378.47
	leaded petrol	5,291.00	leaded gasoline	0.729	3,857.14
	unleaded petrol	479,222.00	unleaded gasoline	0.8	383,377.60
	gas oil, diesel oil, naphtha	10,836,718.00	gas oil (cracked), diesel (US,Canada),naphtha	0.853	9,243,720.45
	fuel oil	1,585,946.00	fuel oil #2	0.853	1,352,811.94

The volume column represents the retained import values provided by the Census and Statistics Department. The approximated item column provides the reader with the

Consumption Analysis of Hong Kong and Guangzhou

items whose densities were used to convert from volume to mass. Because the Census and Statistics Department grouped oil products in the same category (e.g. aviation gasoline and kerosene) the same was done for the approximated item column (e.g. aviation gasoline 100, kerosene). There are various kinds of aviation gasoline and fuel oils in the world, so the ones resembling the ones consumed in Hong Kong were used for the conversion from kiloliters to tonnes. The average density column represents the densities of the approximated items. When Hong Kong grouped items into the same category (e.g. aviation gasoline 100 and kerosene) their respective densities were averaged out. Finally, the last column represents the calculated mass in tonnes of Hong Kong's retained imports.

For gases, Hong Kong's gas retained imports were recorded in tonnes (mass) whereas Guangzhou's were recorded in cubic meters (volume). The cubic meters could easily be converted to tonnes; however the storage pressures for natural gas and LPG were difficult to come by. We emailed the Hong Kong and China Gas Co Ltd., but they did not respond to our inquiries. We could have guessed the storage pressure for both natural gas and LPG but chose not to, thinking that it could lead to a high percent error.

Calculations also needed to be done in the material consumption section. Guangzhou's total industrial production for 1999 was given in Yuan. We converted these values to HK\$ by using the following conversion factor: HK\$ 0,94 / Yuan. Guangzhou's imports and exports were given in US dollars. We converted them to HK\$ using the following conversion factor: 7.7986 HK\$ / US\$.

3.5 Presentation Format - Prototype

A prototype is a way of representing our data. The findings of the consumption analysis were presented in the form of a report, a website and an oral presentation. The report included the consumption analysis as well as various sustainable development plans. The final oral presentation provided a visual representation of the data found and the proposed sustainability measures using pictures, figures and graphs.

We designed a web page hosted by Civic Exchange in order to make our results more widely available. Our consumption analysis will be posted on the web page.

CHAPTER IV RESULTS AND DISCUSSION

4.1 Urban Biomass

Guangzhou had a land area of 7,434 km² whereas Hong Kong had a land area of 1,098 km² in 1999 (Demographia, 2001), (Planning Department, 2001). However, Hong Kong and Guangzhou have very different uses for their land, Hong Kong has dedicated a large portion of land to country parks, whereas Guangzhou has allotted land for agriculture. The urban areas are also developed quite differently, with Guangzhou having a large industrial section and Hong Kong having a financial and services based business section.

In comparing the urban biomass of Hong Kong and Guangzhou, it is important to look at urban population densities, land use and land development planning. Urban population is given in persons per square kilometer. In areas with high population densities as in Hong Kong and Guangzhou, the standard of living is lowered but usually there is less urban sprawl. Hong Kong's limited land area puts many restraints on the land use and future planning. Guangzhou has more land use and future planning opportunities than Hong Kong because it has 7 times the land area.

Hong Kong is one of the most densely populated areas in the world, though only 17 percent of the land is developed, as can be seen in Figure 3. In 1999 Hong Kong had 184 km² of developed land, which included residential and commercial land. In 1999 the urban density of Hong Kong was 36,522 people per km² (Planning Department, 2001).

With an average 30-year life span, most buildings are knocked down and re-built with more floors in order to accommodate the growing population (Koenig, Personal

Consumption Analysis of Hong Kong and Guangzhou

Communication, Jan. 16, 2002). This method of land-use planning has prevented urban sprawl, but increased the urban density.

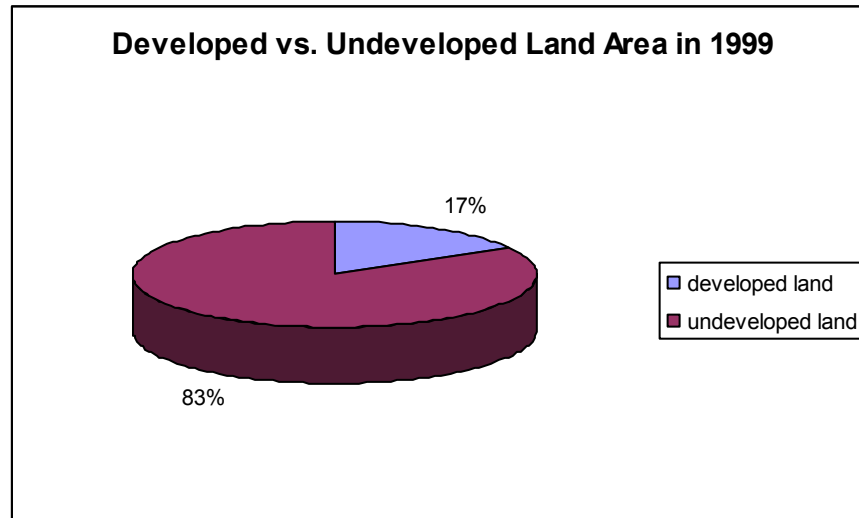


Figure 3 - Developed (built up land) vs. Undeveloped Land for 1999 in Hong Kong SAR (Planning Department, 2001).

Comparatively, in 1999 approximately half of Guangzhou's population lived in the urban area. Guangzhou, with a total land area of 7,434 km², is made up of 8 urban districts: Dongshan, Liwan, Yuexiu, Haizhu, Tianhe, Fangcun, Baiyun, and Huangou, and 4 counties, Panyu, Huadu, Zengcueng and Conghua (Statistical Bureau of Guangdong, 2000). The population density in built up urban areas is similar to that of Hong Kong. In Figure 4 the population densities of both Hong Kong and Guangzhou are over 20,000 persons per km², though the population density in the rural areas of Guangzhou is much less than in Hong Kong. The exact urban population density of Guangzhou is difficult to calculate, because information on the amount of developed land area in Guangzhou is inconsistent.

Consumption Analysis of Hong Kong and Guangzhou

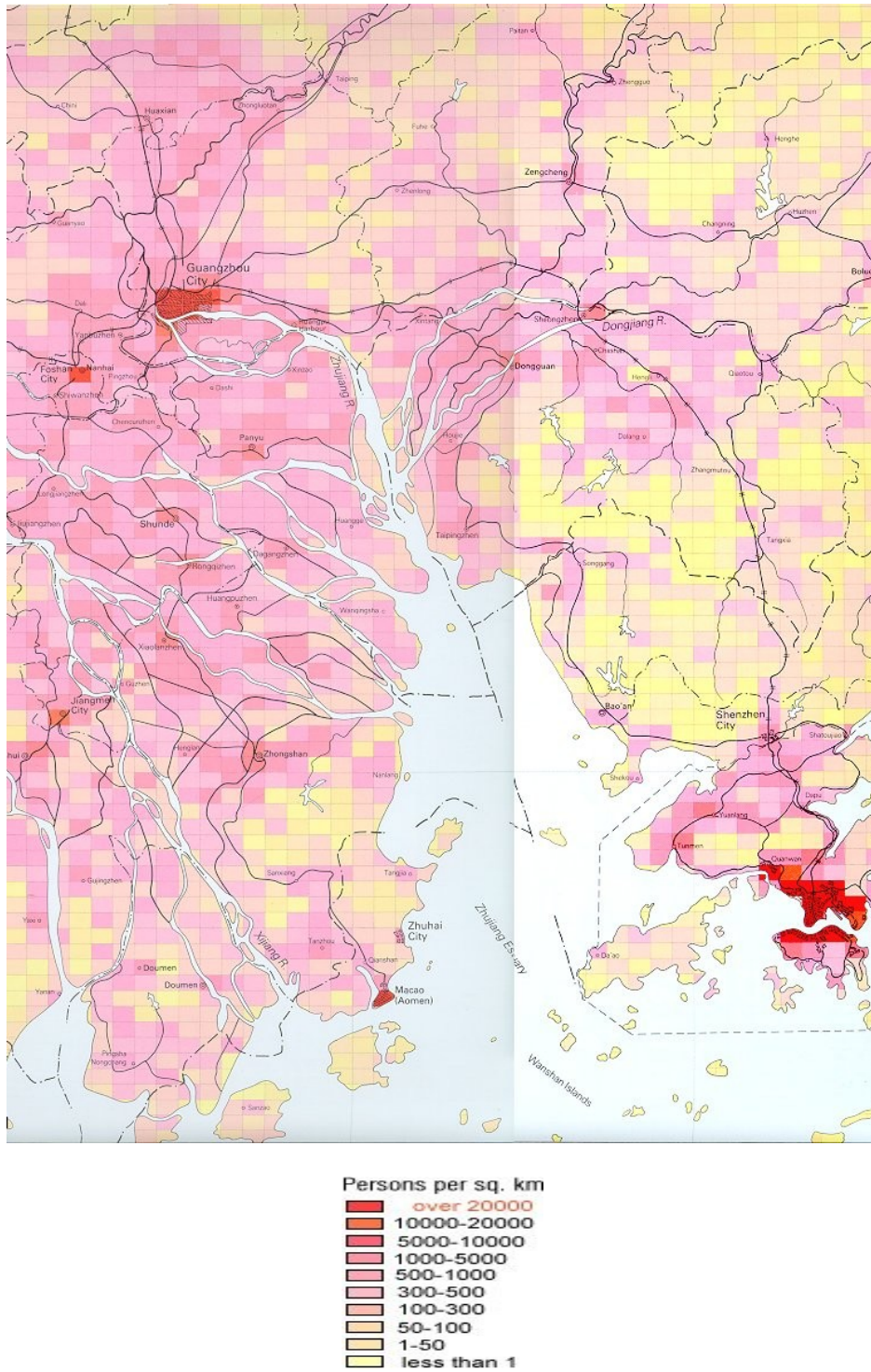


Figure 4 - Population Density map for Pearl River Delta area (Australian Centre of the Asian Spatial Information and Analysis Network, 2001).

Consumption Analysis of Hong Kong and Guangzhou

Guangzhou's urban area is approximately 1,417 km², whereas the total land area of Hong Kong is 1,081 km². This small land area has affected many of the land use planning decisions in Hong Kong (Demographia, 2001). Hong Kong has a very mountainous terrain and ecologically rich areas with high biodiversity, which restricts the areas which can be developed. As Figure 5 shows, Hong Kong uses a relatively large percentage of its developed land for residential living space. Residential area takes up 24 percent of the developed land and another 8 percent is used for public rental housing. Roads, railways and vacant development take up a large percentage of land. Vacant development is land on which are found the current development projects that have not been finished. The vacant development, which comprises 15 percent of the developed land, demonstrates Hong Kong's large turn-over in buildings (Planning Department, 2001).

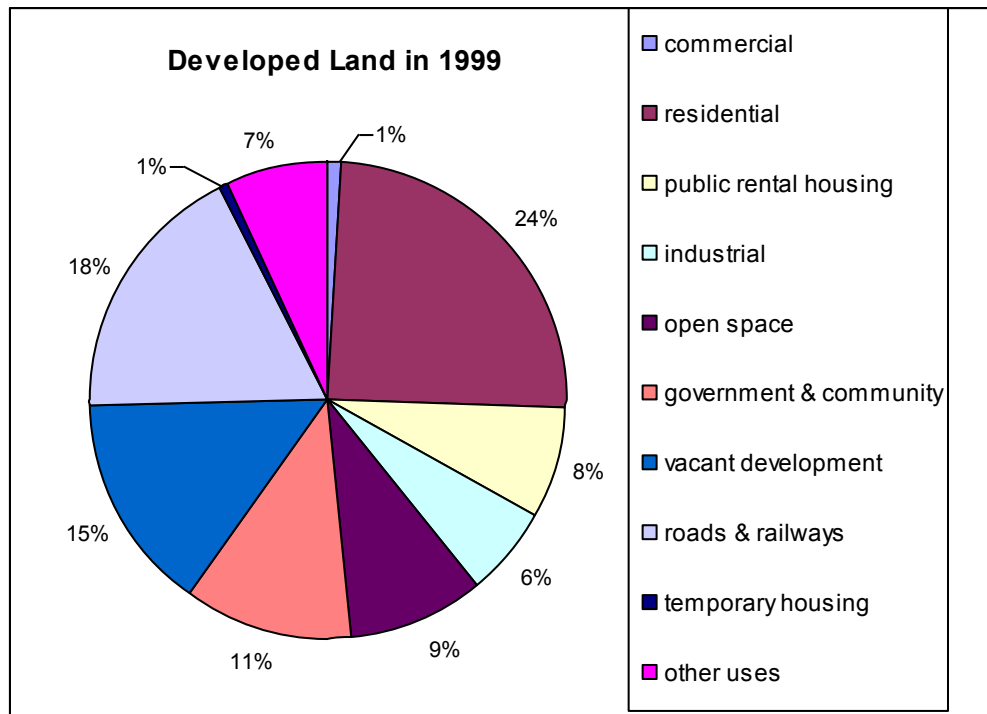


Figure 5 - Usage of developed land for 1999 in Hong Kong SAR in percent of total developed land (Planning Department, 2001).

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong has 40 percent of its land reserved as Country Parks (undeveloped land), which is also used as water catchment areas. The water from these areas runs into the reservoirs which take up another 3 percent of the undeveloped land. There are many areas such as Mai Po Nature Reserve (which includes mangroves and swamps) that have a large biodiversity and are important for the conservation of the ecology of Hong Kong. Figure 6 shows that badlands, swamps and mangroves account for 5 percent of the undeveloped land in Hong Kong (Planning Department, 2001).

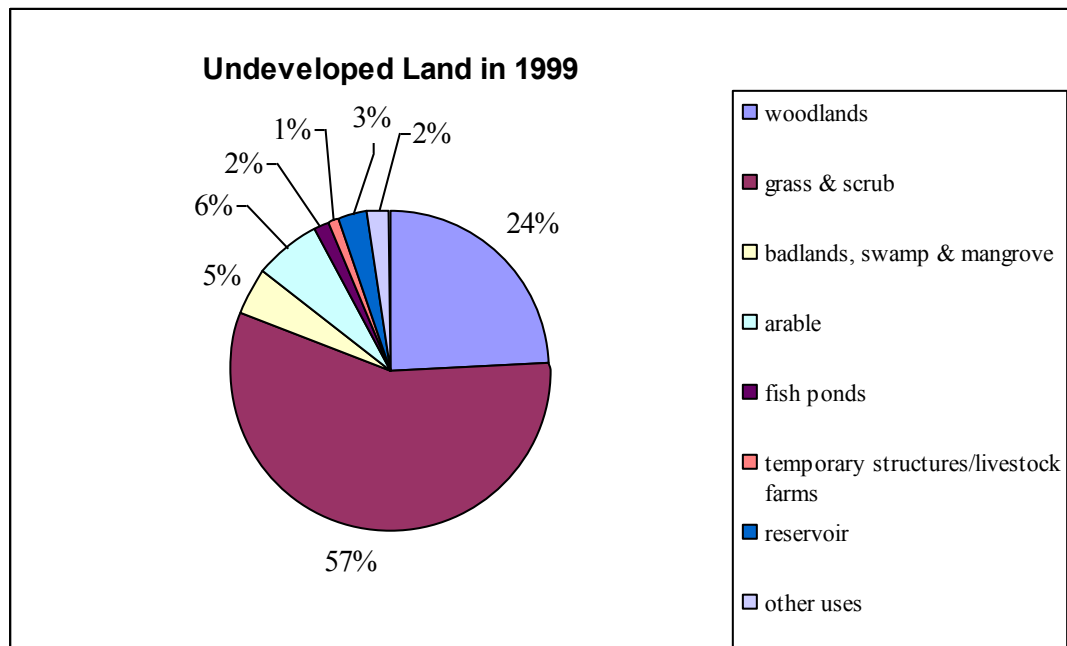


Figure 6 – Use of undeveloped Land in Hong Kong SAR in 1999 (Planning Department, 2001).

The land planning in Guangzhou is quite different from Hong Kong. Hong Kong is focused on service industries, whereas Guangzhou has large areas for light and heavy industry. Guangzhou is the industrial center of Southern China, with over 40 main industrial categories, which demonstrates that much more land is allotted for industry than in Hong Kong (Merebo, 2001). Guangzhou also has land area used for agriculture,

Consumption Analysis of Hong Kong and Guangzhou

whereas Hong Kong has reserved 40 percent of its land for country parks. Food production along with industry is a large part of the economy in Guangzhou (Merebo, 2001). The amount of exports of foodstuffs to Hong Kong alone demonstrates the amount of agriculture in Guangzhou. Much of Hong Kong's land planning deals with the lack of resources in both land and water, whereas Guangzhou has more area to plan for population growth and agriculture.

Hong Kong and Guangzhou have a similar goal of becoming international cities, which has been taken into consideration in their future planning. Although the goal is similar, both cities have different steps to take to reach this status. Hong Kong's densely developed land and the restrictions on land use due to land conservation and mountainous terrain make future planning a difficult task. In order to raise the standard of living in Hong Kong, The Planning Department is hoping to lower the population density by planning more housing in the New Territories. The Planning Department has begun a three stage study in which it is preparing for a growing population (2001). Guangzhou is planning on focusing on developing telecommunications and the financial district of the city in the next ten years (Guangdong Chinapages, 1996). Guangzhou has already developed telecommunications connections with over 1,700 cities and towns in China and over 200 countries and regions throughout the world (Merebo, 2001).

The population of Hong Kong is expected to reach 10 million by 2030. One major obstacle to such growth in a geographically limited area is having enough space for people to live. The metro area could be built to a higher density, or there could be more settlements in the New Territories (Amy Cheung, Personal Communication, Jan 21, 2002). Some of the key factors that are being considered in future planning are: reusing

Consumption Analysis of Hong Kong and Guangzhou

older industrial factory sites for housing, deciding which areas of the New Territories to develop, deciding how densely populated they should be, planning to make Victoria Harbor more aesthetically pleasing, and using the reservoirs for recreation areas. The 2030 planning strategy divides Hong Kong into five sub-regions Metro, South-West New Territories, South-East New Territories, North-West New Territories and the North-East New Territories. In this strategy there are suggestions about the land use in each of these sub-regions.

The metro area of Hong Kong includes Central and Kowloon, has a population of over 4 million and provides 80% of all job opportunities. A major priority is the up keep of this business district through preserving heritage buildings, green planning, and changing urban design to make the area more pleasing to the workers and the residents. The Planning Department would like to add to the developed area in Southern Kowloon and Tsuen Wan, and in western and southern parts of Hong Kong Island. Also plans are being formulated to make Victoria Harbor more of a tourist attraction and a place for residents to go, by providing marine recreational activities (Planning Department, 2001).

The South-West New Territories, an area including Lantau Island, would be used for tourist attractions and recreational areas. There are also opportunities to build new residential areas in Tung Chung and Tai Ho. The southern part of Lantau Island is preserved as Country Parks, and catchment areas for water. Currently Disney is building a theme park on Lantau Island as well (Planning Department, 2001).

The South-East New Territories provides opportunities for building recreational areas, whereas Tseung Kwan O has the potential for new residential developments (Planning Department, 2001).

Consumption Analysis of Hong Kong and Guangzhou

The development in the Northern New Territories gives the opportunity for Hong Kong to develop a better socio-economic link with China. With the new West Rail link, there can be cross-boundary interactions, as well as development along the northwestern area to open up the Pearl River Delta. In the northeast the development of a technology hub, in which the KCR railway would connect the two polytechnic universities in Kowloon, the Hong Kong Technology Centre in Kowloon Tong, the Chinese University of Hong Kong, the proposed Science Park in Pak Shek Kok and the Industrial Estate in Tai Po (Planning Department, 2001). This development could bring more employment opportunities to the New Territories, attracting people away from the metro area and possibly decreasing the urban density.

Sustainable development has been recognized as an important factor for Hong Kong's planning in the next 30 years. The Planning Department has made finding a balance among the economic, social and environmental needs of Hong Kong a principal factor in the 2030 Study. The "Sustainable Development for Hong Kong in the 21st Century" (SUSDEV21) contains the planning tools the department will use to evaluate the sustainable development options (Planning Department, 2001). The assessment of new development will include the following aspects: economic, environmental, land use planning, social and transport (Planning Department, 2001).

Future planning in Guangzhou is not as dependent on such a small areas as Hong Kong. Guangzhou is focusing on international and social development. Guangzhou is the most prosperous foreign trade area in Southern China and is planning to become an international metropolis by 2011.

Consumption Analysis of Hong Kong and Guangzhou

4.1.1 Urban Biomass – Summary

Urban population density in both Hong Kong and Guangzhou is very similar, though land use is very different. Hong Kong has a small land area which makes planning for the growing population more difficult than planning in Guangzhou. Hong Kong uses a large percentage of its land for housing and country parks, whereas Guangzhou uses land for agriculture and industry, Hong Kong does not have the area to develop for these uses. Both cities are focusing land planning on becoming international cities. To reach this goal in Hong Kong, The Planning Department may build in the New Territories to spread the population, which will lower the population density. Guangzhou is developing its telecommunications network and its financial district to reach more of the outside world.

4.2 Water

The issues of water supply for Hong Kong and Guangzhou are very different. Where Hong Kong does not have sufficient water for its population, in Guangzhou water is abundant but very polluted. Guangzhou needs to improve the way it treats its water supply, whereas Hong Kong needs to conserve the water it receive from Guangdong.

Providing an adequate water supply has become a very large task for Hong Kong. For over 40 years now Hong Kong has depended on outside resources to provide fresh drinking water to its population. The city has a granite base which has no significant amount of ground water and no large bodies of fresh water to draw from. To gather water a large percentage of the land is reserved for catchment area and reservoirs. Today the two largest reservoirs are areas that have been re-claimed from sea inlets, the Plover

Consumption Analysis of Hong Kong and Guangzhou

Cove Reservoir and the High Island Reservoir. There are also an additional 15 smaller reservoirs (Water Supplies Department, 1998). Guangzhou, on the other hand, is located north of the tributary of the Zhu Jiang (Pearl River) Delta. The water flow supplies 125 billion m³ yearly to the area, which is 15 times the water needed for the population (U.S. Consulate General Guangzhou, 2001).

In 1999 Guangdong Province supplied 73 percent of the fresh water used in Hong Kong. The other 27 percent came from local catchment areas, which collect rainwater. The supply from Guangdong began in 1960 with an agreement which was made with Hong Kong to receive 22.7 Mm³ of water per year. From this time, the amount of water received from Guangdong has grown. With an agreement made in 1989, Guangdong (starting in 1995) would increase the supply by 30 million cubic meters per year, which brought the total amount of water able to be supplied from 690 Mm³ in 1995 to 840 Mm³ in 2000. The Agreement was revised in 1998. The supply quantity was then 760 Mm³ for 1998, increasing by 10 Mm³ per year up to 820 Mm³ by 2004. In 2000 the Hong Kong Water Supplies Department requested for supply reduction due to high storage level, and actually took 706 Mm³ from Guangdong, so the amount of 780 Mm³ as set in the 1998 Agreement was not needed (Water Supplies Department, 2001).

The water from Guangdong is supplied from the Dong Jiang River (East River). The water is pumped up hill through many pumping stations, until gravity takes over and it flows down the Yantan Tunnel into the Shenzhen reservoir (see Appendix M). From there the water enters the Plover Cove reservoir, the High Island reservoir or the Tai Lam Chung reservoir (Water Supplies Department, 1998).

Consumption Analysis of Hong Kong and Guangzhou

In 1999 Hong Kong's population was nearly 7 million; it had added 600,000 people since 1995. With this growth came the need for more resources. In 1999 Hong Kong received 738 Mm³ of water from Guangdong and another 106 Mm³ from catchment areas, totaling 844 Mm³ of water. The annual water consumption for Hong Kong in 1999 was 911 Mm³ leaving a deficit of 67 Mm³ of water, which would have to be obtained from reserved water from the prior year (as shown in Figure 7) (Water Supplies Department, 2001). Figure 7 also shows a decrease in the annual fresh water consumption from 1995 to 1999. This decrease in annual use is due to a large percentage of the industry moving to China before and after the turn over from British rule to China (Personal Communication, Damien Ku, Jan 23, 2002).

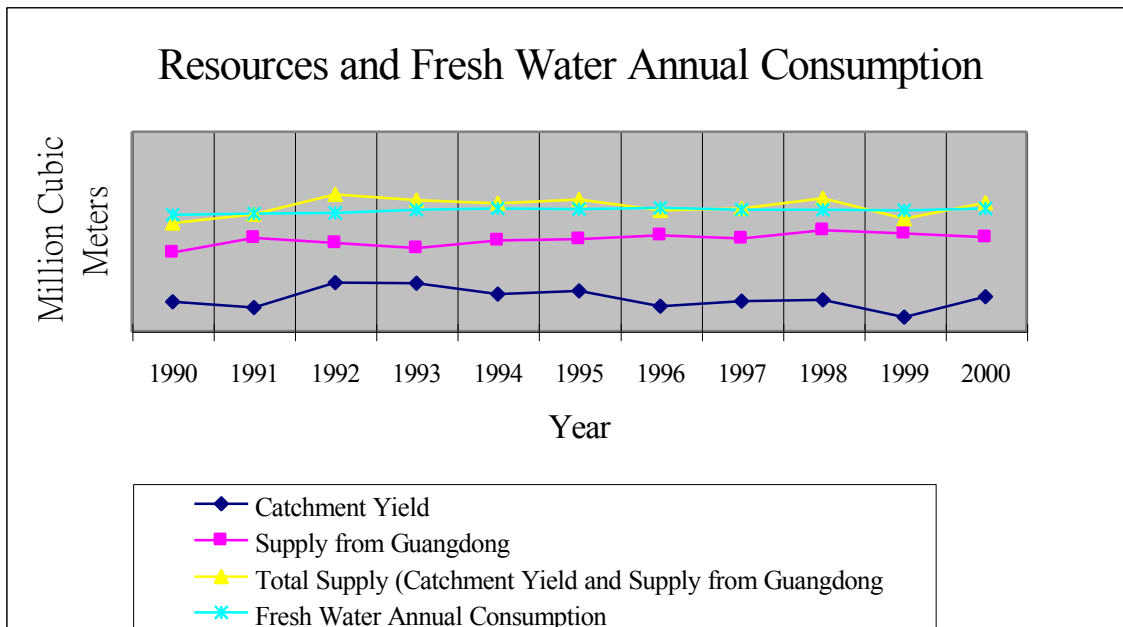


Figure 7 - Freshwater resources consumption in Hong Kong SAR (Water Supplies Department, 2001).

Figure 8 illustrates the impact on water use caused by the movement of industry to Guangdong, with the average growth rate dropping in 1995. It also shows that as the

Consumption Analysis of Hong Kong and Guangzhou

population has grown, as has the average daily water usage. In 2000 the growth rate was at 1.2 percent, while it was – 0.4 percent in 1999 (Water Supplies Department, 2001).

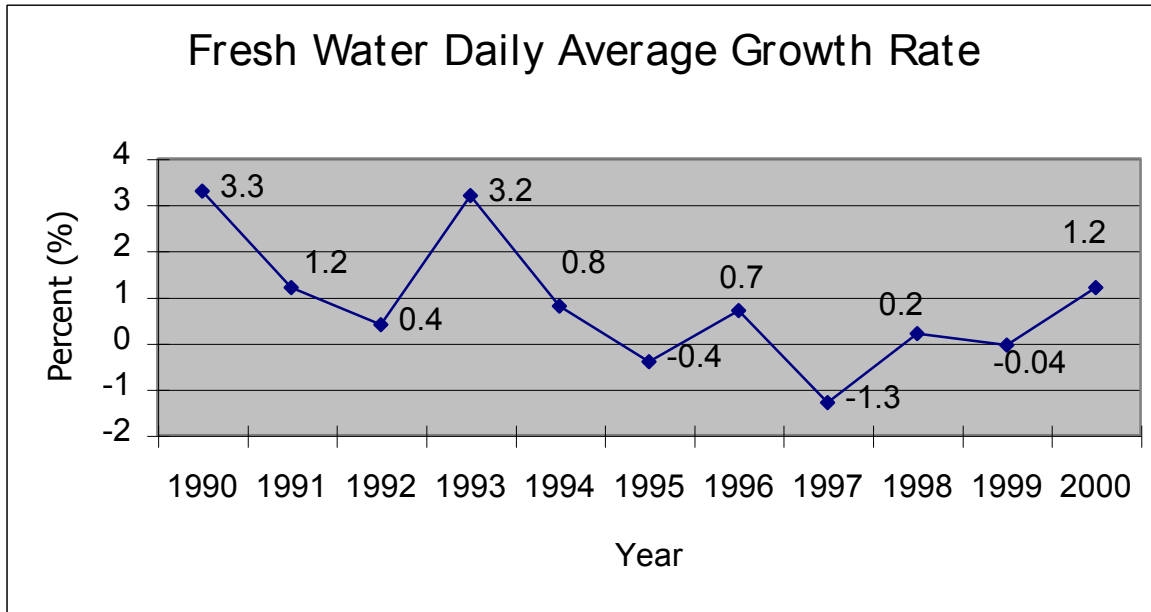


Figure 8 - Freshwater consumption growth rate in Hong Kong SAR (Water Supplies Department, 2001).

A use of non-potable water is utilizing sea-water for toilet flushing. Since the 1950's Hong Kong citizens have been supplied with sea water to use for flushing toilets, and today over 70 percent of the population uses sea water for this purpose. Hong Kong saves over 20 percent of its fresh water by using sea water for flushing (see Figure 9). Sea water does not go through as stringent a treatment process as drinking water. First it is strained, and then chlorine or hypochlorite is added before it is distributed to the public (Water Supplies Department, 2001).

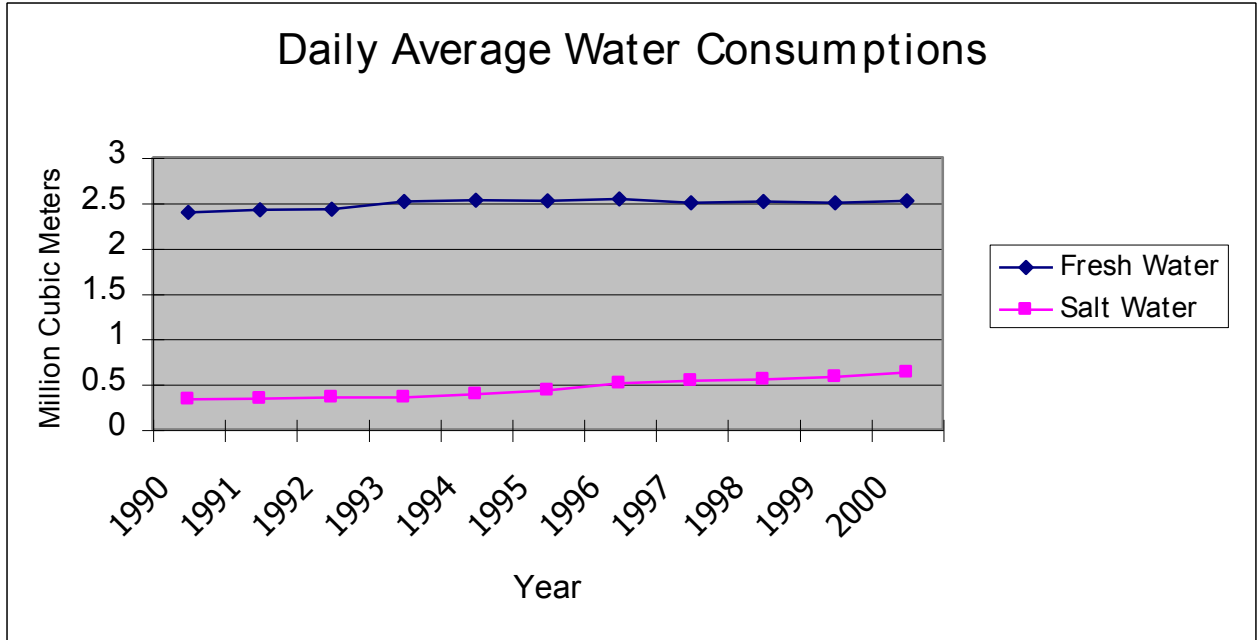


Figure 9 - Daily water consumption in Hong Kong SAR (Water Supplies Department, 2001).

In 1999 the total water consumption in Guangzhou reached 1,096 Mm³, where the residential use was 75 percent of the total water consumption (see Figure 10). The average daily per capita consumption was 0.564 m³, whereas in 1990 it was 0.460 m³ (as shown in Figure 11). From 1990 to 1999 the population of Guangzhou increased by approximately 1 million accounting for the 19 percent increase in water usage. Figure 10 also shows the tap water consumption was at its peak in 1995, which corresponds with the time when industry was moving out of Hong Kong to Guangdong Province. In 1995 the production use of tap water was approximately 1 million m³ more than in 1990 or 1998 (Statistical Bureau of Guangdong, 2000 p.556).

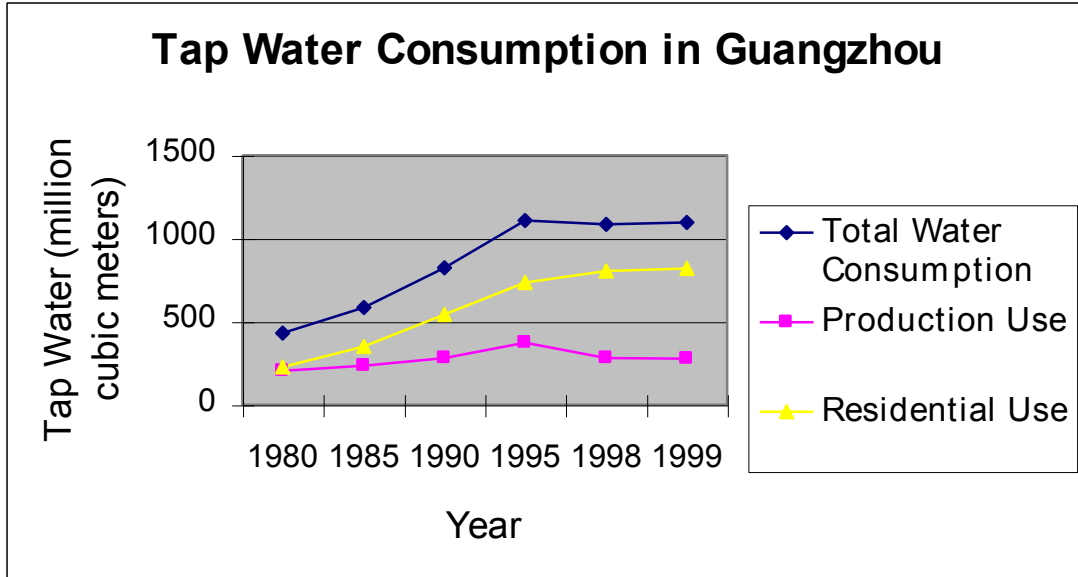


Figure 10 - Annual tap water consumption of Guangzhou (Statistical Bureau of Guangdong, 2000 p.556).

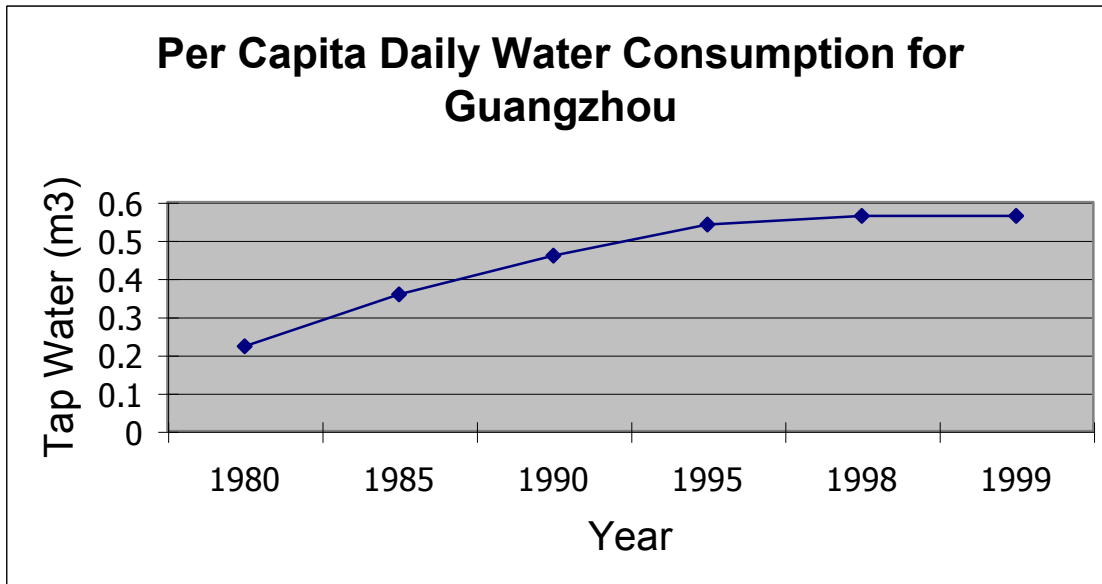


Figure 11 - Daily per capita water consumption for the total population of Guangzhou (Statistical Bureau of Guangdong, 2000, p.556)

Southern China has a plethora of water. The problem of supplying it to the population lies in the issue of water quality. Currently, Guangzhou has one sewage treatment plant that treats only 8 percent of the water and one more treatment plant is

Consumption Analysis of Hong Kong and Guangzhou

being constructed (Cultice, 2001). In 1999, 5.92 billion tons of waste was dumped into the seas, rivers and lakes of Guangdong Province, 2.97 billion tons of which went into the Pearl River Delta. On a daily basis 8.6 million tons of household wastewater was released into the water in Guangdong, two million tons of which was produced in Guangzhou. The province was only able to treat 21 percent of the total waste that was produced, leaving the water supply severely polluted (U.S. Consulate General Guangzhou, 2000).

4.2.1 Water Supply – Summary

Comparatively, Hong Kong uses less water overall as can be seen in Figures 12 and 13. Figure 12 shows that since 1995 Guangzhou has consumed more water than Hong Kong, which can be attributed in part to the movement of industry to Guangdong Province that began around this time. The population in Guangzhou also grew very quickly from 1990 to 1999, with the most rapid growth from 1990 to 1995. This factor also contributed to the steep increase of water consumption during the 1990's (Statistical Bureau of Guangdong, 2000).

In Hong Kong 100 percent of its drinking water meets the World Health Organization (WHO) standards (Water Supplies Department, 2001). The output of waste that was dumped in the Pearl River Delta from Guangzhou and Guangdong Province forced Hong Kong to treat all the water that is drawn from the Dong Jiang River. A large incentive for Hong Kong to become more self-sufficient in water would be economic. Hong Kong could save money both in the cost of the water it gets from Guangdong and the cost of treating.

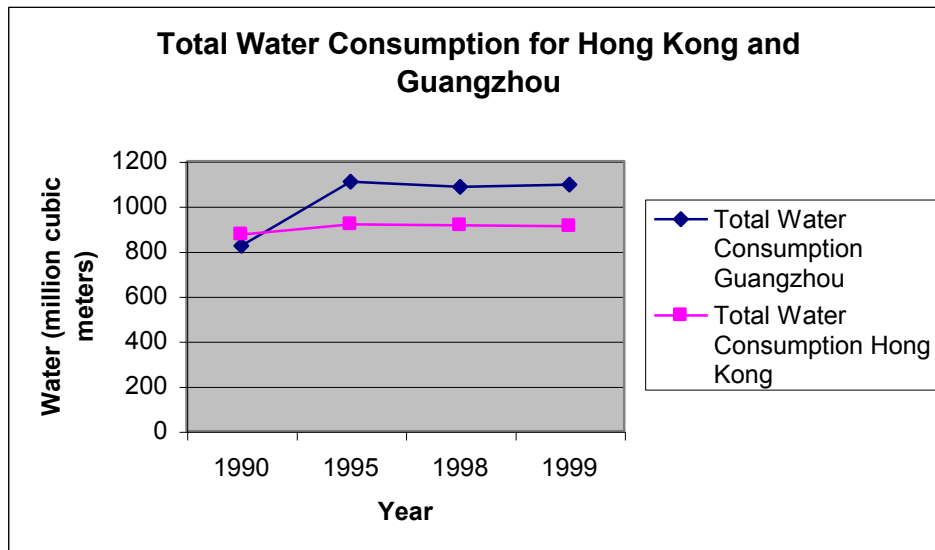


Figure 12 - Total water consumption for Hong Kong, SAR and Guangzhou (Statistical Bureau of Guangdong, 2000, p. 556) (Water Supplies Department, 2001).

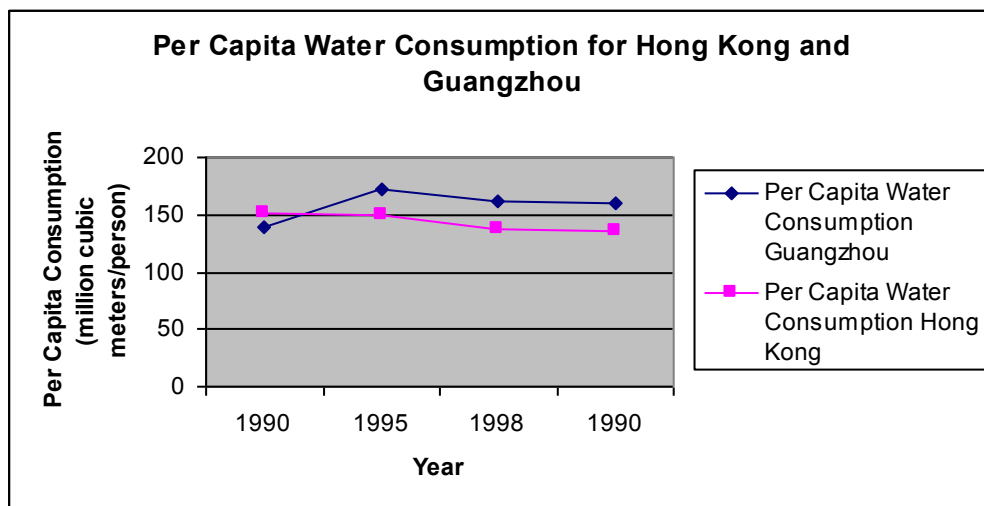


Figure 13 - Per capita water consumption for Hong Kong, SAR and Guangzhou (Statistical Bureau of Guangdong, 2000, p. 556) (Water Supplies Department, 2001).

4.3 Energy

Whenever technology is utilized, energy consumption is used to enable it. From the design stage of a product to its completion and upkeep, energy is consumed to maintain and use the product. Consequently, when discussing energy use in a given region, one must understand that detectable energy consumption trends only reflect general consumption. All forms of energy resource consumption can potentially be touched upon in a consumption analysis; however, the degree to which they can be quantified accurately is minimal at best, and we will therefore be limiting our study to more general energy consumption trends.

In order to analyze the energy consumption in a given geographical area, it is important to examine three different aspects of resource consumption: a territory's energy resource management, the conversions of consumed energy resources and the end use consumption of energy resources.

Hong Kong and Guangzhou's energy resource management encompasses the trade, production and storage of energy resources. Hong Kong and Guangzhou consume coal products, oil products and gasses which are used as fuels, as well as for non-energetic purposes such as oil as a lubricant. Both Hong Kong and Guangzhou are very reliant on fossil fuels in their energy resource consumption.

Although Hong Kong does not generate, produce or refine its coal and oil products, it does export some. These are re-exports, or goods that Hong Kong purchases only to export without actually physically altering them. Hong Kong imports and re-exports much of its oil and coal products to and from countries such as the People's

Consumption Analysis of Hong Kong and Guangzhou

Republic China, Macau, the Republic of Korea, the Republic of Singapore, Vietnam and the Republic of South Africa (Census and Statistics Department, 2001).

In 1999, Hong Kong imported 34,925 terajoules of electricity, all of which were generated at the Daya Bay Nuclear Station in Guangdong. Over 70 % of the electricity produced at this site was exported to Hong Kong. The other 30% were consumed in the Guangdong Province. Daya Bay Nuclear Power station began operation in the early 1990's and since then has continued to increase its yearly contribution to Hong Kong's electricity supply. The HKNIC or Hong Kong Nuclear Investment Company has 25% ownership of the plant. The HKNIC does not participate in the operation of the power station, but it does nominate people for key managerial positions.

Table 7 shows the energy resources on which Hong Kong depended in 1999.

Table 7 - Hong Kong's retained imports in 1999 (units are in 10,000 tonnes unless otherwise specified) (Census and Statistics Department, 2001, pp. 11, 22, 28)

	items	retained imports
		imports + exports
Coal products in tonnes	steam coal & other coal	639.30
	wood charcoal	0.94
	anthracite	0.00
	<i>subtotal</i>	640.24
Oil types and products	aviation gasoline & kerosene	278.70
	leaded petrol	0.39
	unleaded petrol	38.33
	gas oil, diesel oil, naphtha	924.37
	fuel oil	135.28
	LPG	0.0011
	natural gas	0.024
	<i>subtotal</i>	1377.1
Other sources	electricity (terajoules)	30,010

Consumption Analysis of Hong Kong and Guangzhou

As Table 7 indicates, Hong Kong was twice as reliant on oil products (1377.1×10^4 tonnes) as coal products (640.24×10^4 tonnes) to meet its energy requirements. Since 1996, Hong Kong has ceased to consume coke and semi-coke, which are types of coal. Since 1995, the Census and Statistics Department has not distinguished between kerosene and aviation kerosene. Table 7 reflects this accordingly. Furthermore, as of April 1, 1999, leaded petrol was prohibited for sale in Hong Kong.

Guangzhou retained fewer types of fuels than Hong Kong (see Table 8). In addition to these retained imports Guangzhou produced 1,140 tonnes of crude oil, 1.4 tW of electricity (from nuclear power) and 0.40×10^8 m³ of natural gas (Statistical Department of Guangdong, 2000). These numbers can be added to the retained imports to calculate how much of each item Guangzhou consumed in 1999. Guangzhou is therefore mostly dependent on crude oil and crude coal to meet its energy requirements. Compared to Hong Kong, Guangzhou is twice as reliant on coal products (1.239×10^7 tonnes of coal products for Guangzhou vs. 6.402×10^6 tonnes of coal products for Hong Kong).

Consumption Analysis of Hong Kong and Guangzhou

Table 8 - Guangzhou's imports, exports and retained imports in 1999 (units are in 10,000 tonnes unless otherwise specified) (Statistical Department of Guangdong, 2000, pp.154-156)

Items	imports		exports		retained imports
	domestic	external	domestic	external	Imports + Exports
crude coal	1,169.97	19.10			1189.07
clean coal	29.03				29.03
Charcoal	21.77				21.77
crude oil	7.49	554.60	-751.38	-334.95	-524.24
Gasoline	21.07	0.04	-59.45	-15.49	-53.83
coal oil	20.58	11.44	-19.56	-4.85	-578.07
Diesel	22.89	11.12	-123.80	-8.16	-97.95
fuel oil	34.50	139.26	-3.43	-0.79	169.54
LPG	4.61	1.25	-1.34	-1.41	71.59
other oil products	3.60		-0.88	-6.50	-3.78

The People's Republic of China has a substantial reserve of crude coal and oil. Unfortunately, Guangzhou data do not specify the sources or destinations of domestic and external imports and exports. Refined oil is the only energy resource export commodity of which Guangzhou identifies the export destination. Furthermore, Guangzhou groups Macau, Hong Kong and Taiwan into one export destination. It is, therefore, difficult to quantify the direct trade interaction between Hong Kong and Guangzhou.

The resources that Hong Kong and Guangzhou allocated are not all consumed for commercial, domestic and industrial purposes. All countries must maintain a stock of energy reserves in the event of power plant failures or natural disasters. Also, the fueling of vessels and planes needs to be accounted for by retained imports. For instance, both domestic and foreign vessels and planes need to refuel at airports and ports after they arrive.

Consumption Analysis of Hong Kong and Guangzhou

Of all the oil and coal products that Hong Kong and Guangzhou retain, a significant amount is used in transformations to generate electricity and manufacture gas.

Because these processes are not 100% efficient, energy is lost.

Table 9 reflects Hong Kong's energy conversions and losses.

Table 9 - Energy conversions in Hong Kong in 1999 (Census and Statistics Department, 2001, p. 6)

Items	Quantity of energy			Total
	Allocated for conversions	electricity generation	gas manufacture	
Energy equivalent of coal products (terajoules)	192,516.00	-189,492.00	0	3,024
Energy equivalent of oil products (terajoules)	318,127.00	-72,144.00	-27,825.00	218,158
electricity (terajoules)	30,105.00	105,652.00		125,287.00
natural gas (terajoules)			24,687.00	24,687.00

The quantity of energy allocated for conversions reflects an approximation of the energy equivalent of Hong Kong's available fuels. In the electricity generation and gas manufacturing columns, positive numbers indicate energy produced from conversions, while negative numbers reflect energy input for conversions. Finally, the total column denotes energy available for end consumption.

In 1999, 261,636 tJ from coal and oil products were used to generate 105,652 tJ of electrical energy. This was only 40.4 % efficient. Also, 27,825 tJ from oil products were used to produce 24,687 tJ of natural gas. This was 88.7% efficient. In total, Hong Kong lost approximately 169,592 terajoules of energy in 1999 compared to 176,524 terajoules in 1995 (Census and Statistics Department, 2000). Hong Kong's conversion losses have

Consumption Analysis of Hong Kong and Guangzhou

decreased even though energy consumption has been growing. Energy losses cannot all be attributed to inefficiency in transformation processes. Energy consumed by electrical companies is counted as system loss. Energy is also lost due to resistance in wires used for electrical transmission and inefficient end use.

Table 10 illustrates Guangzhou's energy conversions. Negative numbers reflect the consumption of items for conversions while positive numbers show the production of items resulting from conversions.

Table 10 - Guangzhou's energy conversions in 1999 (Units are in 10,000 tonnes unless otherwise specified) (Statistical Department of Guangdong, 2000, pp. 154-156)

Items	Quantity for use prior to conversions	electricity generation	heat supply	refined coal	coal oil	Gas	coal products processing	Quantity to use after conversions
Crude coal	1,209.92	-650.93	-108.02			-2.03	-0.93	448.01
Clean coal	30.04			-29.64				0.40
coal products	0.02						0.97	0.99
Charcoal	24.50			21.78				46.28
coal gas (10 ⁸ m ³)				0.38				0.38
other gas (10 ⁸ m ³)						0.97		0.97
crude oil	594.38	-26.01			-562.59			5.78
Gasoline	-54.14				125.18			71.04
coal oil	6.92				34.08			41.00
Diesel	-91.90	-6.80	-0.46		208.29	-0.01		109.12
Fuel oil	192.36	-107.54	-2.86		27.08	-6.03		103.01
LPG	2.71				17.27	-1.42		18.56
refinery plant gas		-1.05	-3.46		20.86			16.35
natural gas	0.40	-0.40						0.00
Other oil products	-3.60	-1.26	-4.12		86.93			77.95
other burning products				1.44				1.44
Heat (10 ⁸ J)			2,385.25					2,385.25
electricity (10 ⁸ kWh/hr)	14.40	198.15						212.55
other energy sources	16.81	-0.76	-1.48	-0.38	35.79	-0.21		49.77

The majority of Guangzhou's crude resources are utilized in the

Consumption Analysis of Hong Kong and Guangzhou

conversion processes. In tracing the consumption of crude coal in industry, we see that practically 63% of it is used for electricity generation and heat supply. Crude coal consumption is not only inefficient, but it produces a large amount of air pollution when burned. Similarly, 95% of crude oil is refined to produce coal oil and 4% are used for electricity generation. Aside from losses due to inefficient conversions, the energy equivalent of 169,900 tonnes of crude coal, 567,000 tonnes of crude oil and 710,000,000 kWh are lost yearly. This is approximately 100 times more than Hong Kong. These system losses include but are not limited to the powering of the plants that use them as well as transformation and transportation losses. In contrast to Hong Kong, the energy equivalence of fuels is not given, thus making it difficult to establish comparisons between the two.

The producers of electricity in Hong Kong are Hong Kong Electric Co. Ltd. (HEC) and CPL Power Hong Kong Ltd. HEC gets powered from the Lamma Power Station and supplies Hong Kong Island, Ap Lei Chau and Lamma Island (HKSAG, 2000). HEC also has business ties with the Guangdong Electric Power Company. CLP Ltd. is supplied by the Castle Peak Power Company Ltd., which is owned by Exxon and

Consumption Analysis of Hong Kong and Guangzhou

CLP Power Ltd. There are power plants in the New territories, Lamma Island and Lantau Island. These plants are all thermal electric producers. The Black Point and Lamma Island plants use natural gas as main sources of fuels. Because the Census and Statistics Department groups natural gas with oil products, one cannot quantify the growing use of natural gas as a fuel for power plants. Natural gas is a very clean fuel for electricity generation as it produces little waste, no ash and minimal CO and SO₂ emissions. The plants that do not exclusively use natural gas as a fuel use a mixture of steam coal, oil and natural gas.

On July 19, 2000, Guangzhou opened a pumped storage power station in Conghua, which is located 120 miles from Guangzhou. It is the largest of its kind in the world. Although hydroelectric power generation is less polluting than thermal power generation, it is not necessarily more ecologically sound. Large dams have a negative impact on land and natural ecosystems (FoE, 2000). There is also a diesel thermal power plant in Hua County in Guangzhou. Guangzhou gets the remainder of its electricity from thermal and hydro power plants in the rest of the province as well as surrounding provinces.

Once we have accounted for a region's energy requirements and energy losses, it is important to look at the end use of energy resources.

In contrast to Hong Kong's overall energy requirements, coal used to supply energy for end use is a very small fraction of the total energy use (see Table 11). Oil products' contribution to end usage changed from 55% in 1995 to 59% in 1999, while less than one percent of coal products contributed to end use consumption in 1995 and 1999. Changes in electricity and gas consumption have also been minimal.

Consumption Analysis of Hong Kong and Guangzhou

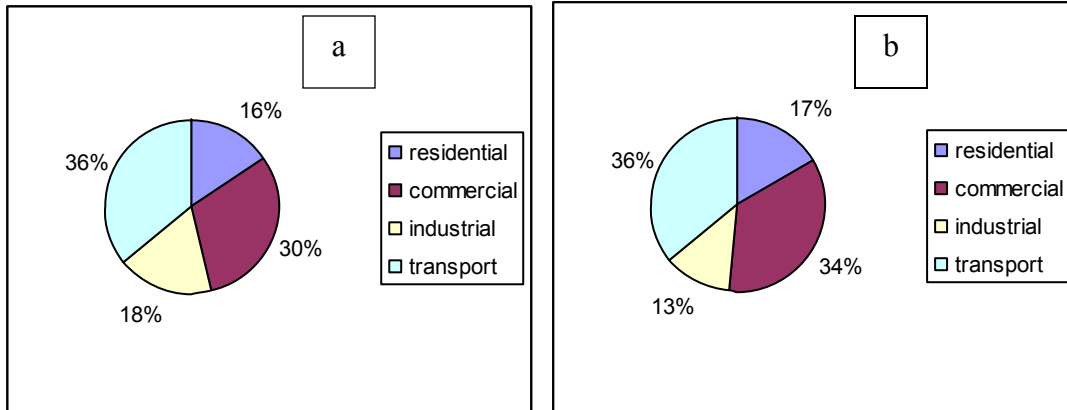
There was a 16% increase in per capita energy end use from 1995 to 1999. Electricity and gas end consumption rose respectively by 17% and 12% from 1995 to 1999. The decrease of gas' end use contribution is due to the increase of oil product consumption. From 1995 to 1999 oil product end use consumption went up approximately 35%. Reasons for this increase are the conversion of taxis to LPG and the decrease in end use of oil products (the Census and Statistics Department classifies LPG as an oil product).

Table 11 - Hong Kong energy end use consumption in 1999 (Units are in terajoules unless specified) (Census and Statistics Department, 2001, p. 9)

fuel type	End Use in 1995	End Use in 1999
coal products	439 (0.2%)	344 (0.09%)
oil products	160,876 (55%)	218,158 (59%)
electricity	107,477 (37%)	125,287 (34%)
gas	21,972 (7.8%)	24,687 (6.7%)
total	290,764	368,476
tJ ca ⁻¹ year ⁻¹	0.0472	0.0548

Although the consumption of electricity and gas in the domestic and commercial sectors increased, their industrial use has decreased. This can be attributed to a continuing emphasis on Hong Kong's service based economy. More industrial and manufacturing companies continue to move to the Pearl River Delta. Figure 14 shows the end use consumption by sector.

Consumption Analysis of Hong Kong and Guangzhou



Figures 14 - Energy end use consumption in Hong Kong by sector a: in 1995, b: in 1999 (Electricity and Mechanical Services Department, 2001)

Hong Kong's energy end use mainly caters to domestic and commercial buildings and transportation. Residential and commercial buildings consume enormous amounts of energy due to inefficient lighting and cooling systems (Koenig and Warren, 2000). In fact, Hong Kong's power demand peaks in the summer time. This is mostly due to the high air conditioning load. Furthermore, the overall problem with the power management system set up in Hong Kong stems from the electric utility's policy to simply support the maximum possible expected peak power demand (FoE, 2000). When Hong Kong does not operate at this level, power generation facilities are not used. Currently, power companies have no incentive to modify power volume or power peaks since it would eventually reduce the unit price of power.

Hong Kong's very high population density and widespread public transportation system lay the framework for efficient public transportation energy consumption; although transport energy end use consumption increased from 1995 to 1999, its percentage in end use consumption has not increased. In 1995, compared to 52 other urban regions ranging from Singapore to Atlanta, Hong Kong had the lowest per capita energy consumption for transportation at 6.5 gigajoules per passenger per year as

Consumption Analysis of Hong Kong and Guangzhou

opposed to 103.3 gigajoules per passenger per year in Atlanta, Georgia (Gilbert, 2001). Figure 15 shows how Hong Kong's different forms of public transportation's energy consumption compare to the previously mentioned 52 urban regions in 1995.

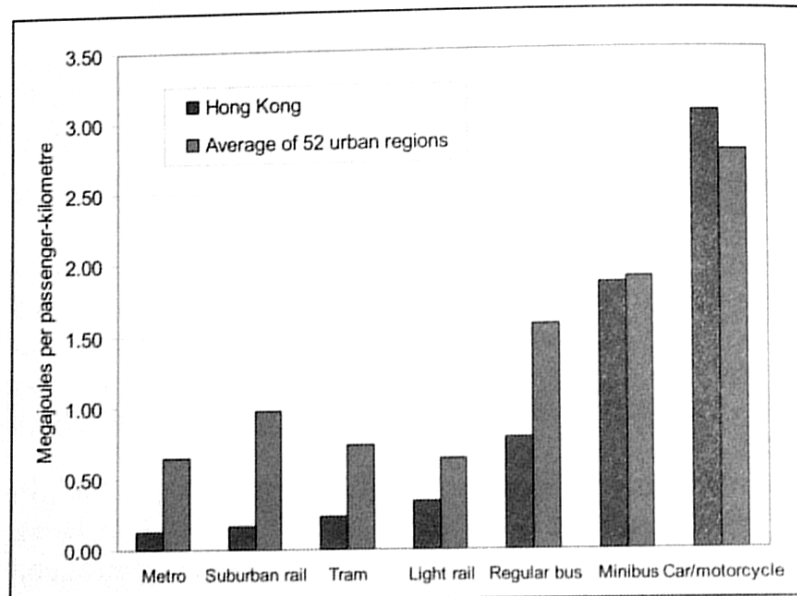


Figure 15 - End energy use by land passenger transport modes, Hong Kong and 52 urban regions, 1995 (Gilbert, 2001, p.9)

This lower energy end use per passenger is mainly due to the widespread use of public transportation as there are only approximately 376,750 privately owned vehicles for 6,850,000 inhabitants.

Table 12 shows energy end use in Guangzhou.

A total of 4,786,900 tonnes of coal products, 3,817,900 tonnes of oil products and 245.25×10^8 kWh/hr were used for end use consumption in 1999. Due to its industrialization, the majority of Guangzhou's energy consumption is for industry. 95 % of coal products, 35 % of oil products and 63% of electricity were consumed in end usage. This is characterized by Guangzhou's high consumption of crude coal, charcoal, diesel and fuel oil. Guangzhou's large surface area leads to it having industrial and

Consumption Analysis of Hong Kong and Guangzhou

agricultural areas; however the latter consumes approximately 1 % of coal products and electricity and 3 % of oil products. 94 % of gases were consumed for industrial purposes and 5 % residential end use.

Table 12 - Energy end use in Guangzhou in 1999 (Units are in 10,000 tonnes unless otherwise specified) (Guangzhou Statistical Yearbook, 2000, pg. 154-156)

Items	agriculture forestry husbandry	industry	construction	transport storage mail	wholesale retail trade	cities	villages	others
	fishing			communications	food business			
crude coal	5.14	406.99	0.07	0.71	8.16	8.81	0.87	0.27
clean coal		0.40						
coal products						0.89	0.10	
Charcoal		46.14		0.08				0.06
coal gas (10 ⁸ m3)		0.34				0.04		
other gas (10 ⁸ m3)					0.09	0.79		0.07
crude oil		0.11						
Gasoline	0.57	14.28	1.44	29.80	0.79	9.55		14.61
coal oil	0.20	0.31	0.02	40.31				0.16
Diesel	8.97	40.84	5.39	37.58	4.42			11.92
fuel oil		66.79	0.63	30.76	0.58			4.25
LPG		5.21	0.01	0.16	0.09	9.55	2.98	0.56
refinery plant gas		16.35						
other oil products	0.26	73.74	0.35	1.91				1.69
other burning products		1.44						
heat (10 ⁸ J)		2,347.42						37.83
electricity (10 ⁸ kW/hr)	3.21	155.53	3.26	3.92	23.62	22.70	14.51	18.70
other energy sources		49.77						

4.3.1 Energy - Summary

Hong Kong and Guangzhou both have energy resource consumption that is heavily dependent on fossil fuels and nuclear power. Hong Kong has a stronger dependency on oil products (2.01 tonnes/ca/yr) and Guangzhou uses a significant more amount of coal products (1.91 tonnes/ca/yr, crude coal in majority) (See Table 13). Both countries have begun to use cleaner and more efficient fuels such as natural gas. However, Hong Kong has continued in this effort by converting its taxis to the use of LPG fuel, and having two electrical power plants in the New Territories which only

Consumption Analysis of Hong Kong and Guangzhou

consume natural gas. Even though Hong Kong's public transportation is heavily reliant on electricity, Guangzhou consumes more electricity per capita due to industrial usage.

Along with their populations, Hong Kong and Guangzhou's energy resource consumption continues to grow, and more sustainable means of energy consumption need to be developed.

Table 13 – Energy consumption summary (Census and Statistics, 2001 and Guangzhou Statistical Yearbook, 2000)

	Hong Kong	Guangzhou
coal products tonnes/ca/yr	0.93	1.91
oil products tonnes/ca/yr	2.01	1.61
electricity tJ/ca/yr	43.8	99.7

4.4 Materials

Material consumption for the purpose of this report is defined as the consumption of raw or semi-manufactured materials by a given region (i.e. Hong Kong or Guangzhou). All the following figures for Hong Kong were obtained from the Census and Statistics Department, and all the figures for Guangzhou were obtained from the Guangzhou 2000 Statistical Yearbook.

The purpose of this material consumption analysis is to draw attention to the consumption of the two cities and show how their material consumptions are related. It is not intended to dramatize the consumption levels and therefore is selective in order to provide a broad view of the material consumption. Raw and semi-manufactured materials such as minerals, unprinted paper products, natural rubber, plastics, non-manufactured metals, non-manufactured and semi-manufactured textiles (i.e. not clothing, footwear, etc.), chemicals, and inorganic raw material are all counted. Limiting the consumption to these raw and semi-manufactured materials provides an overview of

Consumption Analysis of Hong Kong and Guangzhou

the total material (non-manufactured and manufactured) consumption of Hong Kong and Guangzhou.

In order to sustain the citizens and businesses of Hong Kong and Guangzhou a massive amount of materials is needed each day. Materials are considered to be any type of goods that are not in any other consumption category.

Calculating the consumption of these materials has proven to be difficult, as they are often counted as part of a manufacturing process, e.g. raw cotton and fiber are used in the manufacture of clothing. The consumption calculations are also difficult because much of the raw material data are expressed in terms of money, not weight or number of items.

There are a few ways to calculate Hong Kong and Guangzhou's material consumption: calculate what was imported, exported, and domestically produced and thus sold, or calculate what was thrown away, based on weight. Calculating material consumption by measuring the amount of waste the cities create and dividing it by the population gives us a number representing the physical amount of material waste each resident produced. However, this method results in a distortion of the true material consumption. Generated waste often contains much food waste and other waste that would not otherwise be counted in material consumption. Calculating material consumption by waste also neglects all the materials consumed but not disposed of by residents. Such items include clothes, plastics, rubber and any recycled materials such as paper.

Calculating material consumption by determining monetary values of material imports, material exports, and domestically produced and sold materials is a more

Consumption Analysis of Hong Kong and Guangzhou

reasonable assessment of the true material consumption of the city. However, there are also flaws in this type of calculation, the main flaw being that raw materials are mostly used in manufacturing goods before being sold to residents. By counting manufactured materials, there is a risk of double counting raw or imported materials thereby inflating the actual material consumption. Another flaw is that these materials are often calculated in terms of monetary values, and thus a consumption analysis would be in terms of dollars and cents. Since prices often fluctuate within a given year, the end of the year estimates for the total sales of a given item are representative of the average price over the given period and thus are not as accurate as a consumption analysis done by weight.

Other factors that contribute to material consumption include the population density and standard of living. Hong Kong consumes fewer materials than many other world cities of similar population and size. This is a result of the density of the developed land. Fewer materials are needed to construct, furnish, and sustain habitation in a dense population than a population that is more spread out. The standard of living contributes to the material consumption directly. A higher standard of living directly relates to a higher material consumption. Therefore, standard of living must be taken into account when comparing two cities such as Hong Kong and Guangzhou. Hong Kong is considered to have a moderate standard of living, less than comparable cities in countries such as the United States of America or Germany, but higher than cities in countries such as Thailand or India. Guangzhou's standard of living is one of the higher ones in China and while it is difficult to compare to Hong Kong's standard of living, is above that of cities in countries such as Thailand or India.

Consumption Analysis of Hong Kong and Guangzhou

Taking into account the factors discussed above along with the available types of data, the results of Hong Kong and Guangzhou's material consumption are in terms of Hong Kong dollars. The amount of each subset of materials imported, exported, and domestically sold were calculated based the data from on the Census and Statistics Department. The statistics for Guangzhou were obtained from the Guangzhou Statistical Yearbook 2000 which provided us with 1999 data on industrial production and imports. Similar to the Hong Kong data, all the figures are economic in nature and have been converted from Yuan to Hong Kong dollars.

In 1999 Hong Kong consumed approximately HK\$57 billion of materials or approximately HK\$8000 per person (Census and Statistics Department, 2001). Figure 16 shows each material as a percentage of the total dollar value. See Appendix K for actual dollar values of each material

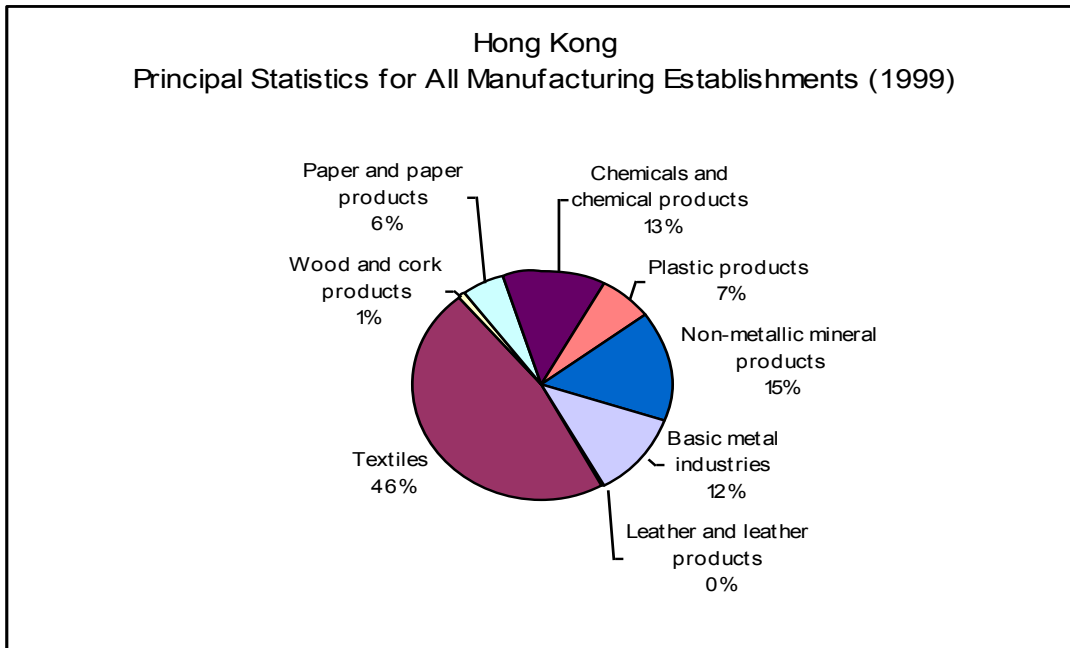


Figure 16 - Principal statistics for all manufacturing establishments in Hong Kong in 1999 (Census and Statistics Department, 2001, p. 75)

Consumption Analysis of Hong Kong and Guangzhou

As can be seen in Figure 16, most of Hong Kong's consumption is in textiles valued at over HK\$26 billion dollars. The textile figures do not include wearing apparel, footwear, leather, or other manufactured clothing. Paper and paper products do not include printing, publishing or allied industries. Non-metallic mineral products do not include petroleum or coal products. Basic metal industries do not include fabricated metal products or machinery. Wood and cork products do not include furniture.

The consumption of paper and wood products has been decreasing in recent years due to technological innovations such as email. The widespread use of email has reduced the amount of paper consumed by businesses. However, plastic product consumption has been increasing in recent years, as has that for polystyrene products. For instance, approximately 120 tonnes of Styrofoam containers are thrown out every day in Hong Kong.

In 1999 Guangzhou consumed approximately HK\$39 billion of materials or approximately HK\$5700 per person (Statistical Bureau of Guangdong, 2000, p275). Figure 17 shows each material as a percentage of the total dollar value. See Appendix J for actual dollar values of each material.

Consumption Analysis of Hong Kong and Guangzhou

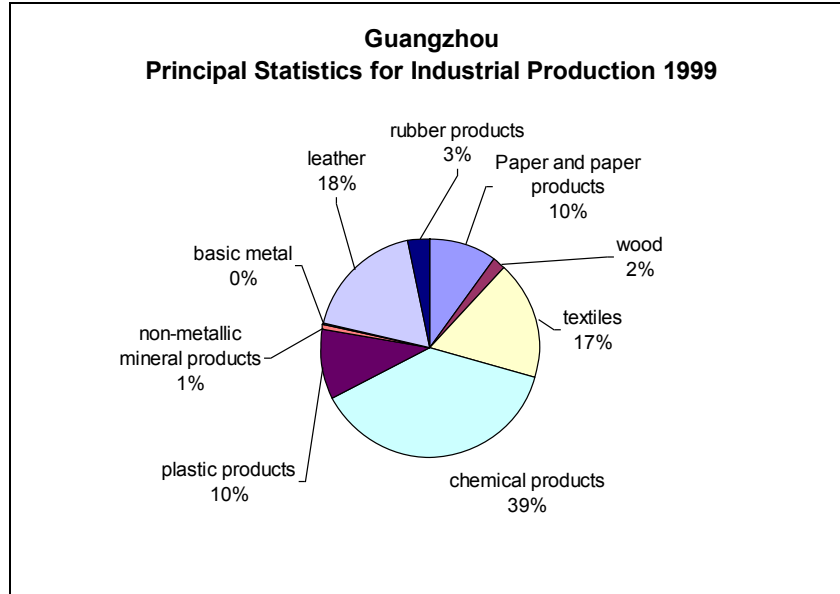


Figure 17 - Principal statistics for industrial production in Guangzhou in 1999 (Guangzhou Yearbook, 2000, p. 275)

As can be seen in Figure 17, the largest percentage of Guangzhou's material consumption is in chemical products valued at over HK\$13 billion. Chemicals are followed by textiles and leather valued at approximately HK\$6.4 billion each.

There is another type of material consumption that Hong Kong is responsible for: imports, exports, and re-exports. Exports and re-exports are not part of any material consumption in Hong Kong because these materials are brought in, or produced locally and shipped out of Hong Kong and thus not consumed in Hong Kong. As can be seen in Figure 18, the value of imported materials into Hong Kong is approximately HK\$112 billion, while re-exports is HK\$85 billion.

Re-exports made up approximately 75% of all imports into Hong Kong, which was due to many factors. Some of the re-exports were raw or semi-manufactured materials that were processed in Hong Kong (i.e. the shape of the material was permanently changed from the form in which it was originally obtained.) Some of the re-

Consumption Analysis of Hong Kong and Guangzhou

exports were materials or manufactured products that were being routed through Hong Kong. Since exports and re-exports are not counted in Hong Kong's material consumption, it is important to show how important they are to Hong Kong.

Hong Kong also has a strong economic relationship with mainland China. In 1999 Hong Kong exported approximately 70% of its total re-exports (\$53 billion worth of materials in the form of textiles and plastics) to mainland China (Census and Statistics Department 2001, p. 60, 61). Hong Kong also imported approximately 50% (\$42 billion worth of materials in the form of textiles) of its total re-exports from mainland China.

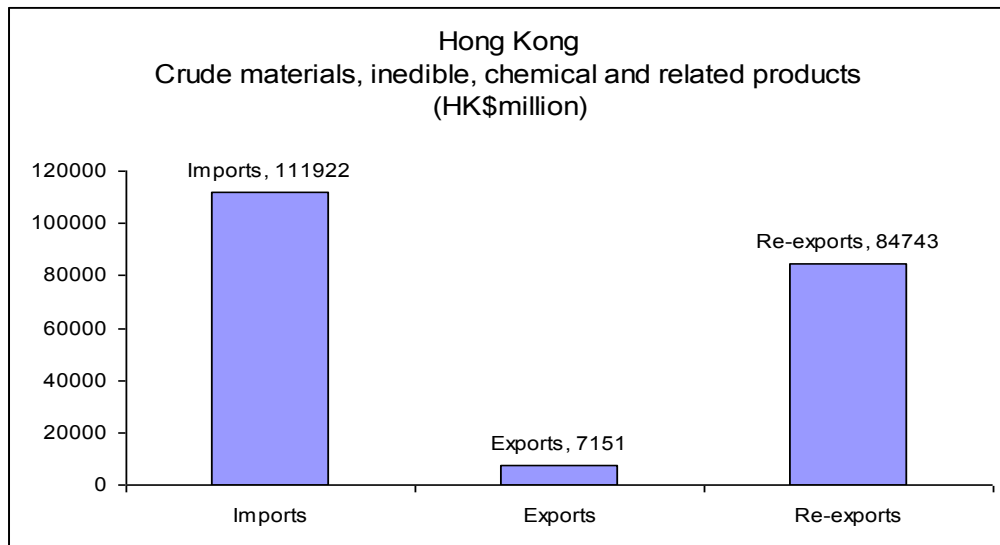


Figure 18 - Import, export, and re-export figures for crude materials, inedible materials, chemical and related products in millions of Hong Kong dollars (Census and Statistics Department, 2001 pp. 53, 54)

The economic link between Hong Kong and mainland China can be seen in Figure 19 which shows the value of imports from Hong Kong and exports to Hong Kong in relation to Guangzhou's total imports and exports. Guangzhou imports approximately HK\$5.5 billion of materials from Hong Kong and exports HK\$25.7 billion to Hong Kong. Figure 19 shows the total imports and exports along with the imports from Hong

Consumption Analysis of Hong Kong and Guangzhou

Kong and exports to Hong Kong. These figures are total imports and exports for all materials manufactured and non-manufactured.

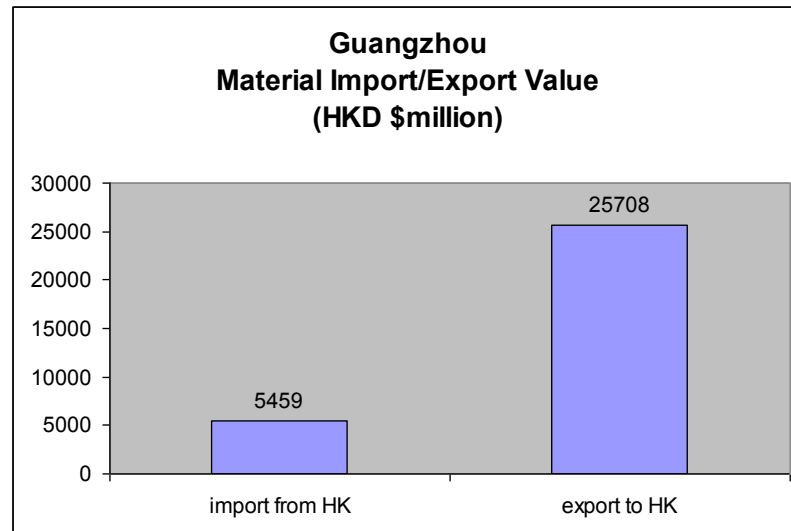


Figure 19 - Guangzhou Import and Export Totals to/from Hong Kong (Guangzhou Statistical Yearbook 2000 p. 433, 435)

4.4.1 Materials - Summary

As can be seen by comparing Guangzhou and Hong Kong (see Figure 20), Guangzhou does not import or export nearly as much as Hong Kong (Hong Kong imports and exports are in billions of dollars, while Guangzhou's imports and exports are only in millions of dollars). However, a significant portion of their total exports, nearly a third, are sent to Hong Kong.

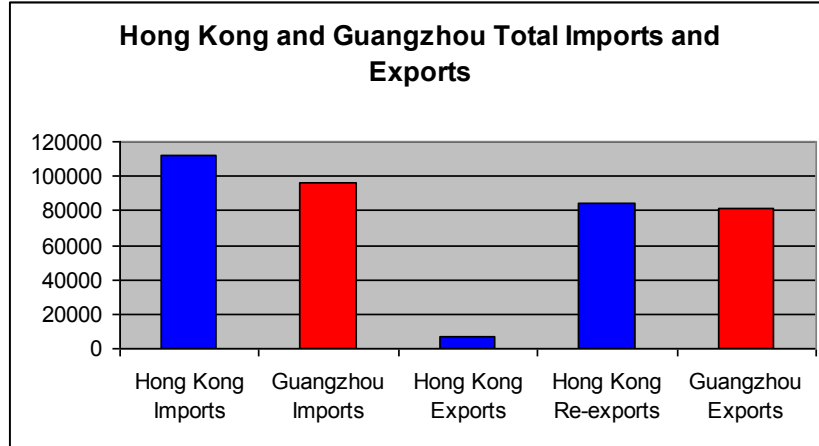


Figure 20 – Hong Kong and Guangzhou Total Imports and Exports (Census and Statistics Department, 2001, pp. 53, 54) (Guangzhou Statistical Yearbook, 2000, p. 433, 435)

According to 1999 data, in Hong Kong each person consumed approximately HK\$550 of plastic products, HK\$500 of paper products, and HK\$50 of wood products per person each year. Guangzhou consumed approximately the same amount of paper products at HK\$520. Wood products were approximately double that of Hong Kong with HK\$105 and plastics are about the same with HK\$550 per person. The material consumption's of Hong Kong and Guangzhou continue to increase and without measures to make material consumption sustainable will continue to create waste.

4.5 Food

Food is an important aspect of a consumption analysis. With other categories such as materials, energy, and urban area, there is, in general, the option of switching to other resources when one becomes scarce. It is crucial, however, to ensure that the methods we use to produce the food we eat are sustainable and renewable enough to supply the world population now and for generations to come.

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong and Guangzhou are very different in terms of the ways that they supply their populations with food. Hong Kong's land is not very suitable for crop and livestock production. There is heavy urbanization in all of the areas that have potential for food production, and most of the other land is mountainous and unusable for food production purposes. Some of Hong Kong's landscape is fit for growing crops, but the costs of turning this land into farmland are too high. Some of these lands are being used as country parks, water catchments, and for other types of utilization that are more profitable for Hong Kong. Figure 21 shows the per capita food consumption for Hong Kong in the food categories where statistics could be found for 1999.

The rice category makes up nineteen percent of Hong Kong's total food supply. This category includes rice, noodles, and other wheat products. These types of wheat products are very popular among the Hong Kong people, and rice or noodles are served with almost every meal. This kind of meat and cereal grain based diet with minimal local production reduces the pollution from animal husbandry and agriculture in Hong Kong itself but moves the environmental impact to other areas, mainly Mainland China. As is illustrated by Figure 21, the people of Hong Kong consume more meat than any other food group by weight. Pork and chicken are the most widely consumed meats followed by beef and then lamb. A majority of this meat is imported from various countries, Mainland China and Australia being the main sources. Poultry is the only meat that has been produced locally more than imported, as is shown in Figures 22 and 24.

Consumption Analysis of Hong Kong and Guangzhou

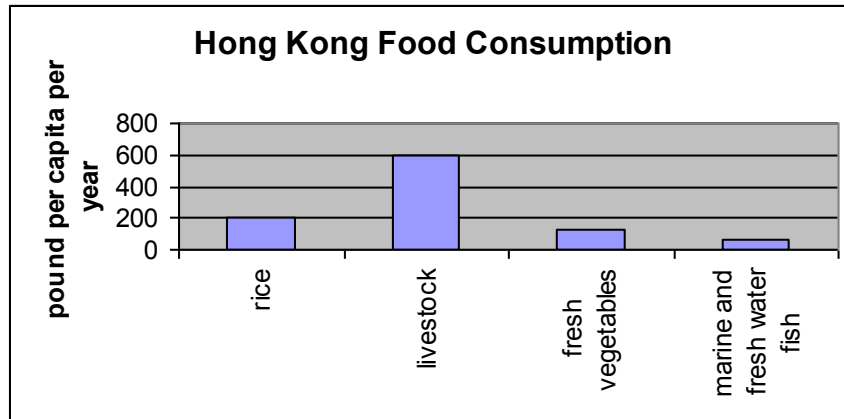


Figure 21 - Hong Kong's Food Consumption for rice, livestock, fresh vegetables, and fish (Census and Statistics Department, 2001, pg. 234-236)

Guangzhou and other areas of China experienced diet changes in the 1980s and 1990s. Meat consumption per capita has quadrupled in Mainland China since 1960. The consumption of rice has decreased from 37.5% of the total consumption to 27.7%. Also, fish consumption per capita per year has more than quadrupled since 1960, increasing from 4.4 kg per year to 18.3 kg per year (The International Institute for Applied System Analysis, 2001).

This kind of trend means a larger impact on the environment. Raising animals for slaughter creates problems with water contamination due to excrement from the livestock. This excrement contains high nitrate-nitrogen levels as well as microorganisms that cause dysentery, typhoid and hepatitis (KSU, 2001). If the feed used was totally organic, 75% of the nutrients consumed by the animal could be returned to the soil as fertilizer for crops, however, the feed often contains chemicals and antibiotics. Manure is still used as a fertilizer in China. Totally organic manure adds needed nutrients to the soil, improves water-holding capacity, and improves aeration. Manure from animals feed with chemical feed does not contain the same nutrients (Jahns , 2000).

Consumption Analysis of Hong Kong and Guangzhou

Guangzhou does not have the same impact on the environment that Hong Kong has. One of the reasons for this is that Guangzhou and other developing areas in China still do not consume as much meat and seafood per capita as Hong Kong, even with a trend of increasing consumption of these foods. Therefore, there are fewer wastes from raising animals and less chance of over-fishing (even though some of the fish consumed are produced in fish farms). The production of wheat, vegetables, fruit, and other grains has less of an impact on the environment and natural ecology of an area than raising livestock and is in general more sustainable and renewable, although the production of these items does create problems due to too much water and chemical use. The fact that more of the food that Guangzhou consumes is produced locally also helps sustainability. Figure 21 gives the amounts of some of the food consumed per capita in Guangzhou.

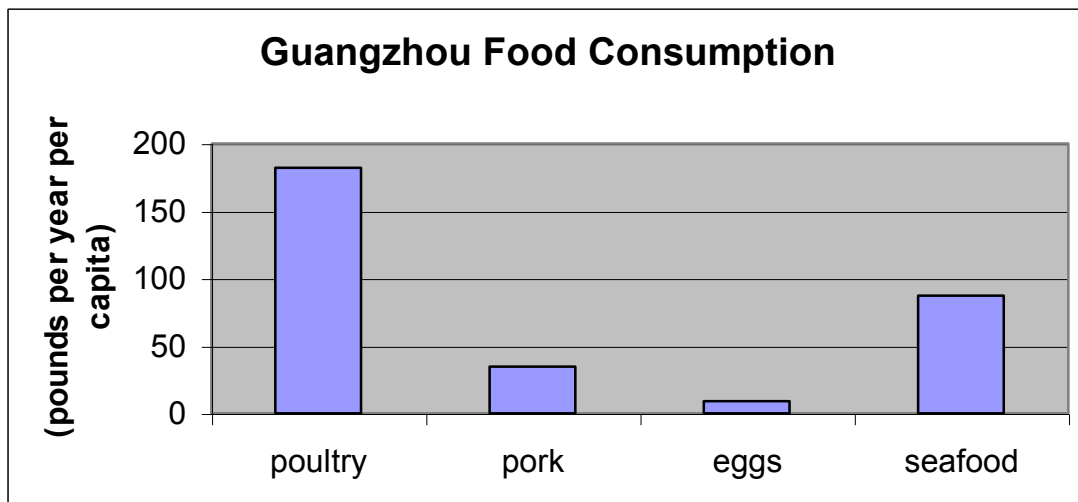


Figure 22 - Guangzhou's Food Consumption for poultry, pork, eggs, and seafood (Guangzhou Yearbook, 2000, pg. 237-238, 150-153)

From Figures 23 and 25, it can be seen that in Hong Kong every food group, except for poultry and dairy, is imported much more than it is produced locally. Within

Consumption Analysis of Hong Kong and Guangzhou

the dairy and eggs group, dairy products are largely imported, while there is a large production of eggs locally.

Figure 24 shows some of the foods produced locally in Guangzhou. Though Guangzhou's per capita consumption rate of food is similar to Hong Kong's, it receives little food through imports.

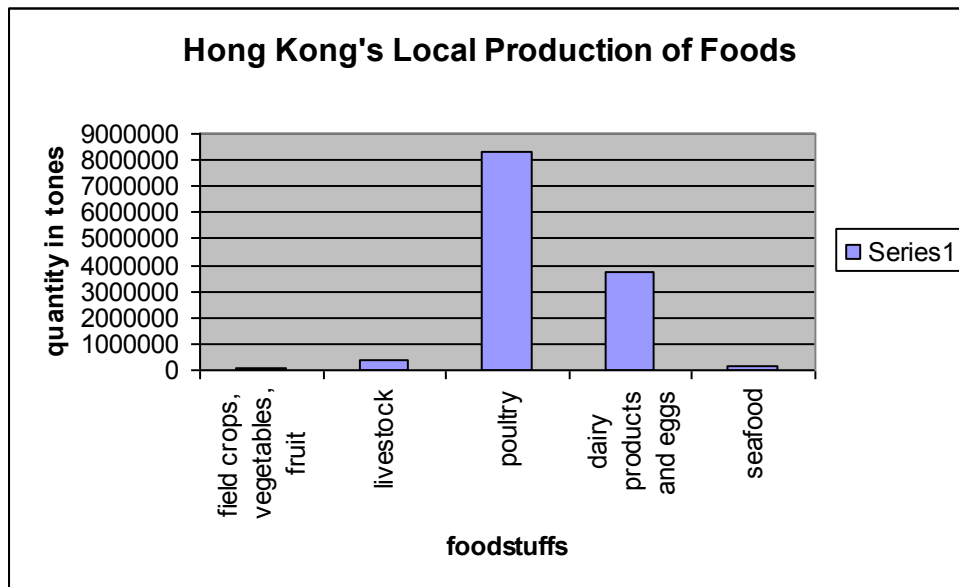


Figure 23 - Hong Kong's Local Food Production (Census and Statistics Department, 2001, p. 235)

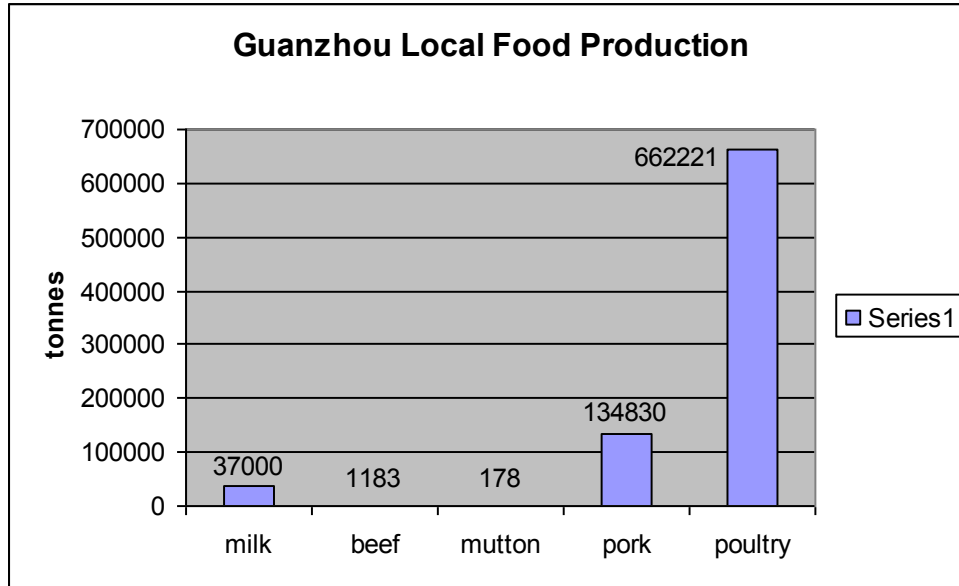


Figure 24 - Guangzhou's Local Food Production (Guangzhou Yearbook, 2001, pg. 237-238)

The biggest difference between Hong Kong and Guangzhou's food production lies in imports and exports. While Guangzhou produces a large amount of food and exports some of that food to other countries and areas, Hong Kong exports almost no food and imports a huge quantity of the food it consumes. Figures 25 and 26 show these imports and exports.

Consumption Analysis of Hong Kong and Guangzhou

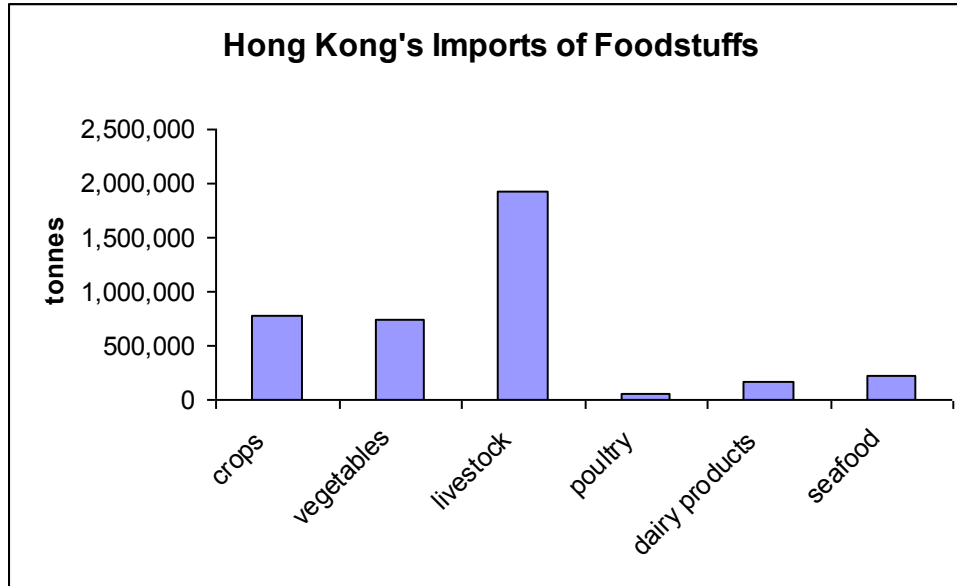


Figure 25 - Hong Kong's Imports of Food (Census and Statistics Department, 2001, p. 236)

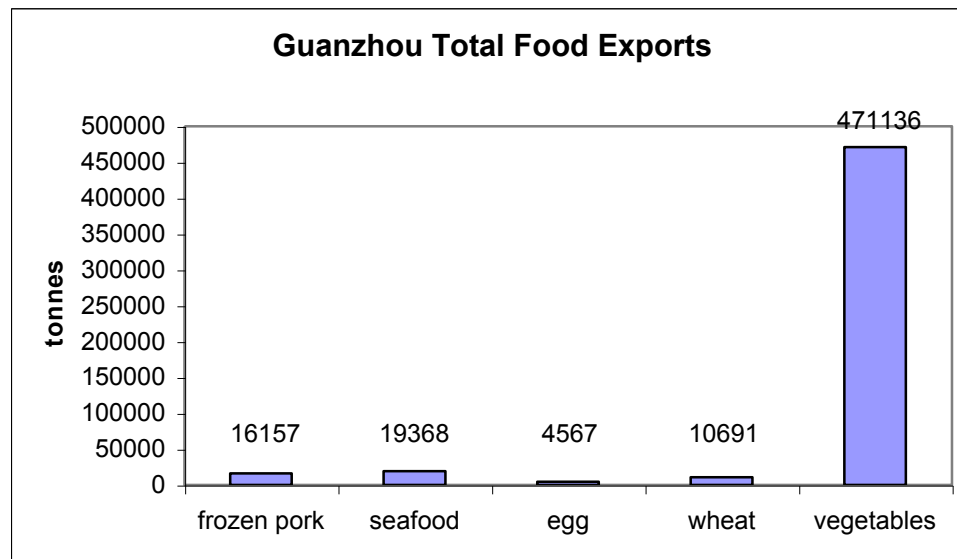


Figure 26 - Guangzhou's Exports of Food (Statistical Bureau of Guangdong, 2000 pg. 150-153)

Although the majority of Hong Kong's food imports come from Mainland China, it receives food from all over the world. Australia, Thailand, and the United States are the next largest sources of imports after Mainland China. Table 14 shows which countries or areas export which kind of foods to Hong Kong. For a breakdown of which countries export the most amount of food in each food category see Appendix L.

Consumption Analysis of Hong Kong and Guangzhou

**Table 14 – Sources of Hong Kong’s food imports (Census and Statistics Department, 2000, pg. 3-32)
Countries That Export Food to Hong Kong Organized by Food Category**

	Mainland China	Brazil	New Zealand and Australia	South East Asia	North America	Africa	Europe
Meat	1	1	1	1	1		
Poultry	1	1			1		
Cereal Grains	1		1	1	1		
Fruit	1	1	1	1	1	1	
Vegetables	1		1	1	1		1
Dairy and Eggs	1		1		1		1

Key

1 = country exports given food to Hong Kong

Table 15 shows to which countries Guangzhou exports its food.

**Table 15 – Guangzhou’s Exports (Statistical Department of Guangdong, 2000, pg. 444-445)
Guangzhou’s Exports Organized by Country or Area**

	Hong Kong, Macao, and Taiwan	The rest of Asia	Japan	Latin America	Europe	United States	Mexico and Canada
Live pig	All						
Live poultry	1	2					
Frozen pork	1	2		3			
Seafood	1	2				3	
Egg	All						
Wheat	1	2					
Vegetables	1	2	3				4

Key

- 1 = country or area receiving most exports
- 2 = country or area receiving second most exports
- 3 = country or area receiving third most exports
- 4 = country or area receiving fourth most export

4.5.1 Food - Summary

There are two main differences in Hong Kong and Guangzhou’s food consumption. First is where the food that they consume comes from. The import-export

relationship between the cities places Hong Kong in a position where they have some control over what and how Guangzhou produces. Hong Kong's capital is a large source of income for Guangzhou and the province of Guangdong. There are almost no exports of food from Hong Kong and imports of food into Guangzhou are minimal.

The second main difference is diet. Hong Kong consumes nearly 600 pounds of meat per capita per year. Guangzhou's diet consists of more rice and cereal grains although Guangzhou's diet has changed considerably in the past three decades. Meat consumption per capita has quadrupled since 1960. As these diets become more unsustainable, more problems with production will arise.

4.6 Sustainability

Hong Kong is now taking sustainable development into consideration in future planning. To develop sustainable strategies Hong Kong must first develop a structure for sustainability to thrive. This includes implementing on-going education programs, encouraging the participation of the public, opening lines of communication between government departments, and increasing the flexibility of projects (having short and long terms goals) (Rooks and Smaling, 2001).

Education programs play an important role in public awareness and raise concerns about the current environmental conditions and the future of Hong Kong. On-going education programs are important to keep the public aware of the current issues in sustainability. These programs should include knowledge about ecology, assessment and project management. This knowledge could help the public to give educated suggestions for the areas in which they live. Another important issue is cooperation and

communication among all the government offices in order to make the process of decision making regarding sustainable development easier. With these lines of communication open, the government departments can plan public fora to get feedback from stakeholders on the impact of planned projects. In planning new developments flexibility is vital. Planned projects should have both short and long term goals to account for any unforeseen problems. Integrated assessment should be included in project planning and the project itself. This assessment will help get the feedback from the public multiple times before the project is finalized. This can insure that the goals of the project have not gone in a direction that is displeasing to the public.

So far, the Hong Kong SAR government has used top down planning methods to design policies. However, in the past couple of years, the incorporation of stakeholders into crucial stages of the planning process has begun to develop. The increased knowledge of the public and stakeholders through means of education and communication will increase the public's desire to take initiative in developing sustainability.

4.6.1 Urban Biomass

Land use planning should be a decision-making process that "facilitates the allocation of land to the uses that provide the greatest sustainable benefits" (United Nations, 1997). These decisions are based on socio-economic conditions, the population growth and the land area. The development of Hong Kong's 2030 study ties these factors together in planning for the future. A main goal set out by the Planning Department in Hong Kong is to raise the standard of living in the territory. In order to do this, the

Consumption Analysis of Hong Kong and Guangzhou

population density needs to decrease, although with the population predicted to reach 10 million in 2030, this will be a difficult task. Spreading residential living areas to the New Territories would give more living space to Hong Kong residents. Hong Kong must at the same time develop employment opportunities in these areas; currently the non-metro areas of Hong Kong only offer 25 percent of the employment. The possible development of a technology hub in the Northeast New Territories would create new jobs.

Ecological planning is also an important factor in new development. Hong Kong has just recently begun requiring Environmental Impact Assessments (EIA) for areas being considered for new development. These EIAs are important for discerning the impact on the ecology and biodiversity of an area. In Hong Kong, if an area with ecological significance (i.e. habitat for endangered species, an area with rich biodiversity, etc.) is discovered during the development of a project, the project is reassessed and moved, if possible. If the project cannot be moved, it will be continued. To protect and sustain the ecology of Hong Kong, it is important to develop an ecological index for each area. Currently there are many species that are not understood. In order to preserve the habitats of Hong Kong's native species, it is necessary to record all the species in the area and what habitats they need to survive. The land area of Hong Kong is relatively small. For this reason it is probable that the undeveloped areas could be surveyed and ecological assessments could be done on these areas without much difficulty. This would help make plans more ecologically sound before developing the land.

4.6.2 Water

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong and Guangzhou both have problems providing their populations with an adequate water supply. Hong Kong does not have its own natural resources to supply its population, whereas Guangzhou has the water resources to supply its population, but the water quality is poor. In both areas planning for a sustainable source of high quality water is necessary.

An example which Hong Kong could look to is Singapore. Singapore has very similar water constraints to those of Hong Kong whereby Singapore also imports a large portion of its potable water because of lack of local resources (The Ministry of the Environment, 2001). For this reason Singapore has instituted a water conservation plan in which on-going education and programs about water conservation are offered to the public, all non-domestic water users are required to have water-saving devices such as flow regulators and self-closing delayed action caps, all newly developed areas are required to have low capacity flushing cisterns, The Public Utilities Board (PUB) conducts audits of large water users and encourages the recycling and reuse of water, and there are tariffs on water usage which increases with the usage of the water (The Ministry of the Environment, 2001). Singapore has also created some very innovative ways to save water, which could be implemented in Hong Kong. The PUB and the Ministry of the Environment of Singapore have developed NEWater, which is high quality non-potable water that is suitable for industrial use. The NEWater treatment plant uses techniques such as reverse osmosis to treat water. Singapore also plans to purchase desalinated water to supplement their water intake (The Ministry of the Environment, 2001).

Since in Hong Kong the amount of water available is limited, it is difficult for the water resources to be sustainable in this territory. For this reason Hong Kong needs to

Consumption Analysis of Hong Kong and Guangzhou

plan for water conservation. Many of the conservation plans used in Singapore could be applied in Hong Kong. The Water Supplies Department could develop a similar on-going education program on water conservation and quality for the people of Hong Kong. Making people aware of such things as tap flow regulators which reduce bathroom the tap from running 20 liters/min to 5 liters/min and the kitchen tap from 30 liters/min to 15 liters/min (Flow Control Water Conservation Ltd., 2002). Requiring non-domestic users such as people in the restaurant business to use water-saving devices such as the self-closing delayed action cap (which turns off the water after a preset time) would help to conserve water. The Water Supplies Department already increases the cost of water as the amount of use goes up, which is an incentive to use less. Recycling water could be a big factor in conservation. Recycled water is treated waste water that can be used for agricultural and landscape irrigation, industrial processing and toilet flushing (Environmental Protection Agency, 2001). Hong Kong could use any treated waste water for the future green landscaping that the Planning Department is developing. Also using more seawater for toilet flushing would benefit Hong Kong. Currently 70 percent of the flushing water is sea water. If the use of sea water for flushing could be increase to 100 percent that would help to save even more potable water.

Another problem in wasting water is the loss of water due to leakage in the pipes. The Hong Kong Government does not have jurisdiction over all the water mains; many are under privately owned lands. The government can only recommend fixing the mains when they get worn out. The worn mains that are not fixed add to a large percentage of the overall leakage (Water Supplies Department, 2001). Some measures have been taken to reduce the amount of loss. The Water Supply Department is now using sensors, which

Consumption Analysis of Hong Kong and Guangzhou

can detect a leak acoustically. Leakage detection enables the Water Supplies Department to locate and repair the problem quickly, thus reducing loss and saving water. The Department also monitors the pressure in the pipes so that during the night when there is less water usage, the pressure is decreased, thus reducing water loss from leaking pipes (Water Supplies Department, 2001). It would also help to develop legislation requiring water mains to be maintained on private land, to prevent leakage over time.

Guangzhou has more than enough water to sustain its population, though the water is severely polluted by the industrial and domestic sectors of Guangdong Province. Guangdong Province planned to have 40 percent of its waste water treated by the end of its Ninth Year Plan in December 31, 2000. This goal was not achieved. The date was pushed back to 2002 for the Pearl River Delta and to 2005 for the whole province. Much of the delays came from administrative problems with urban water supply, sewage discharge and waste water treatment, all being under different jurisdictions (U.S. Consulate General Guangzhou, 2001). Right now it is most important for Guangzhou to build more treatment plants. To do this the lines of communication need to be opened up between all the administrators involved. In China the Ministry of Water Resources is responsible for resource planning and management, the Ministry of Construction is responsible for water treatment and the National Environmental Protection Agency is responsible for legislation on water treatment and discharge regulations. To build treatment plants and make regulations for water quality efficiently, one department should be assigned jurisdiction over the supply and quality of water (U.S. Consulate General Guangzhou, 2001). Guangdong Provincial government did launch the “Green Water Project” in 1997 to reduce water pollution. In 1998 and 1999, 660 industries that

Consumption Analysis of Hong Kong and Guangzhou

were discharging pollutants into the water were either shut down or forced to reduce the pollution output. Another 357 were moved to areas where they would cause less of an impact on the water. By 2000, 89 percent of the industries emitting pollutants were managing their waste by the standards set by the Green Water Project (U.S. Consulate General Guangzhou, 2001).

For future planning in Guangzhou, the NEWater system that is being implemented in Singapore could also be applied in Guangzhou. This would be even more important for Guangzhou than Hong Kong, because there is more industry in Guangzhou. This would bring down the production use of tap water, which was 25 percent of the total usage in 1999.

4.6.3 Energy

Environmental concerns have begun to dictate policies on energy consumption. This can be seen in transformations for electricity generation. In the 1970's, electricity was generated with the combustion of fuel oil. By the 1980's, coal was predominantly used to generate electricity. Although the main use of coal in Hong Kong is to generate electricity, more natural gas is being used. Natural gas produces low emissions of CO and SO₂ when purified and combusted. Although the combustion of natural gas is less polluting than with other coal and oil products, it is important to remember that these resources have limited availability. They are only a temporary solution to our current energy resource needs.

Not only are fossil fuel supplies limited, but they are also polluting. The technologies associated with the use of oil products generally seem to be less polluting

Consumption Analysis of Hong Kong and Guangzhou

than those used with coal products. However, thousands of liters of oil products seep into the ground and waterways yearly. Illegal dumping and gas station underground storage tanks contribute to leakages every year (FoE, 2000). Like many other countries, Hong Kong imports petroleum products which need to be transported by petroleum carriers, and, every year, these same carriers, due to oil spills are responsible for black tides which ravage natural ecosystems.

Since 2000, the Electricity and Mechanical Services Department has instated schemes to promote energy efficiency. First, imported and manufactured household and office appliances must be labeled for energy efficiency (2001). This will hopefully phase out the manufacturing of less efficient appliances as well as enable consumers to buy products according to their energy efficiency. A water cooled air conditioning system scheme is in its early stages. The EMSD is conducting a two year pilot scheme started in May 2000 which designates areas of non-domestic buildings and provides these areas with detailed information on cost assessment and requirements involved in converting to water cooled air conditioning towers. 17 sectors are currently involved in this scheme. A downside to this scheme is that new sectors who want to partake in it must complete an application process and can thus get rejected. Although it is not apparent that the WSD and EMSD would have many reasons to reject applicants, the application process can slow down the information exchange process. By the 2018, it is estimated that water cooled air conditioning systems will save HK\$977 million to HK\$1500 million per year and reduce yearly greenhouse gas emissions by 9.40×10^5 per year. Finally, Hong Kong Electric Co. Ltd. (HEC) and CPL Power Hong Kong Ltd. have agreed to an energy efficiency program in which the EMSD provides rebates for apartments and offices

Consumption Analysis of Hong Kong and Guangzhou

which upgrade their lighting, air conditioning and refrigerator efficiencies. This is a 3 year plan that will end in June 2003. Although these schemes are in their early stages, they can only positively affect energy resource consumption in Hong Kong.

Hong Kong has been taking steps toward sustainable development in public transportation. Since 1999, taxis have been switching over to use LPG as fuel. The cross over from diesel to LPG's for taxis is scheduled to be complete by 2005. The use of LPG instead of diesel will help to reduce polluting air emissions as well as increase the "road life" of taxis. It is estimated that an engine running on LPG has a life ranging anywhere from 402,000 km to 640,000 km as opposed to 320,000 km on diesel (World Power Systems, 2000). A similar conversion proposal is being worked on for the "light" or mini buses, and will be implemented if when more LPG filling stations become more available. The rest of the diesel public transport vehicles should follow in the same footsteps, unless a cheaper and cleaner alternative to LPG is developed. In the meantime, diesel engines are very reliable, and light diesel fuel is approximately two thirds as expensive as LPG. By reducing oxidized gas when the exhaust comes in contact with the converter's catalyst, diesel converters have the ability to cut down on CO and hydrocarbon air emission by 80% (Clean Air Systems, 2000).

Coal is one of the People's Republic of China's most abundant resources, the PRC is currently conducting research on clean coal technology with integrated gasification, combined cycle generation, fluidized bed combustion, low NO_x combustors and flue gas treatment techniques (Illinois Clean Coal Institute, 2001). It is apparent that China's lenient industrial air emissions legislation has not spurred the use of more modern combustion technologies as companies in China continue to buy old technology

Consumption Analysis of Hong Kong and Guangzhou

plants from overseas. Furthermore, the air emissions caused by coal combustion have large health risks.

The Guangzhou Institute of Energy Conversion (GIEC) has been researching methods to utilize waste to generate heat and electricity (United Nations Economic and Social Commission for Asia and the Pacific, 2002). Two municipal solid waste power generation plants are in the making, one having the capacity to handle 900 tonnes per day producing 14,000kWh and the other 2,000 tonnes per day producing 31,000 kWh. However, these have rather expensive maintenance costs and still produce polluting air emissions. The GIEC is also looking into Energy Self Supported Municipal Solid Waste Integrated Systems, which are essentially waste self sufficient (energy-wise) sorting plants that utilize pyrolysis and gasification of part of their waste to supply themselves with power and then proceed to sort, compost and recycle the remainder of the waste.

As oil and coal consumption continue to rise, it is inevitable that the current oil and coal reserves will run out at a faster rate; and as this happens it would be naïve to think that change in fossil fuel prices would remain independent of current supplies. As the world's oil reserves continue to run out, fossil fuel users will inevitably become more dependent on one region, the Middle East, since this is the area with the largest oil reserves. Realistically, it would be impossible for a given area to abruptly end its dependence on fossil fuels.

A transition phase is needed during which fossil fuel consumption is decreased. Due to their efficient characteristics, natural gas and LPG are good examples of this. Simultaneously, technology harnessing the natural power of wind, waves, sun, hydrogen, etc., needs to be developed to a point where they can become economically sustainable to

Consumption Analysis of Hong Kong and Guangzhou

use. Once this happens, a flexible power distribution system needs to be put in place, which will enable the fusion of fossil fuels and natural power into one generation and distribution grid (FoE, 2000). This grid could be managed by one body, thus enabling alternative power sources to be connected to it.

It is important to keep in mind that many Hong Kong companies are moving to the mainland of China to bypass stricter pollution regulations in Hong Kong. Many of these businesses are in the area of the Pearl River Delta, and their emissions come straight down to Hong Kong. They are one of the *main* contributors to Hong Kong's current air pollution. Socio-ecological responsibility needs to be further stressed in Hong Kong, in order for this to carry over to surrounding areas. Much of this could be fixed if Hong Kong adopted a Socially Responsible Investment Strategy which would generate financial support for clean air technologies (FoE, 2000). As Hong Kong shifts its economy away from industry and towards the service sector, tourism has the opportunity to play an important part in the GDP growth. Project such as the building of Disneyland reflect this. However, the ever increasing levels of pollution can only act as a deterrent to tourism.

The interaction between Hong Kong and China should not be limited to the exchange of resources and the simple limiting of pollution. Hong Kong can play an important role in providing China with new sustainable technology and more flexible loans to enable it to sponsor sustainable development programs. "This is an opportunity for Hong Kong to develop a clean energy future, to invest in a sustainable future with a guaranteed growth potential, and to create social stability with new long term jobs" (Friends of the Earth, 2000).

4.6.4 Materials

Recycling is one of the best ways to make material consumption more sustainable. Raw materials as well as glass and plastic can be reused through recycling. Hong Kong residents throw out a little more than 6 million tonnes of waste per year (Environmental Protection Department, 2002). In order to reduce the amount of materials that get thrown away, Hong Kong began to institute a recycling program. In 2000 the Environmental Protection Department stated that Hong Kong recycled approximately 34% of the municipal waste generated, which is about 1.8 million tonnes of paper, plastic, glass, and wood. At present, the recycling program is not mandatory for businesses and residential areas. However, the amount of overall waste recycling has risen over the past few years showing a trend towards recycling. Today, Hong Kong has a recycling campaign similar to the United States' "Reduce, Reuse, Recycle" campaign. There are approximately 8000 bins set aside for recycling around Hong Kong with plans to double that number with in the coming years. However, these bins are not clearly visible and are often tucked away in alleys and side streets. In walking from Waterloo Road in Yau Ma Tei, (Kowloon) to Dundas Street in Mong Kok, there were approximately 12 regular trash receptacles clearly visible and no recycling bins. There were also at least 4 convenience marts within this vicinity which sell food and drinks in plastic and glass containers as well as newspapers and magazines. All of these materials are easily recycled, and yet there are no bins in which to throw away these materials. This situation is representative of the rest of Hong Kong. The waste bins are easily available for people to throw away the materials that could otherwise be easily recycled.

Consumption Analysis of Hong Kong and Guangzhou

In addition to recycling Hong Kong residents are encouraged to use less disposable materials and more renewable materials (i.e. use glass or paper cups instead of Styrofoam).

Friends of the Earth described many possible methods to increase material recycling in Agenda 2047 (FoE 2000). Many of their suggestions are to increase education of the public by making materials able to be recycled clearly marked with the recycling classification. In other words, they suggest that all products come with a bar code in order to identify where they should be recycled.

Other benefits from increasing the recycling in any region are the creation of skilled jobs (FoE, 2000). Recycling centers would need skilled material scientists as well as clean production centers in order to efficiently and properly manage the material waste. Such a need would create skilled jobs in the recycling sector thereby opening a whole new economic door, possibly making recycling a profitable industry. In order for such a thing to happen, however, the quality of recycled materials would have to increase. As of now the quality of a recycled material cannot be guaranteed. If the quality could be guaranteed, with the use of new technology and skilled laborers, then recycled materials would not only become more useful but more marketable thus making material consumption more sustainable.

Guangzhou's material waste is handled very differently from Hong Kong's. It can be recycled in the newly built recycling center which can handle approximately 300 tons of waste per day (China Environmental Protection, 2002). However, most of the municipal waste that could otherwise have been recycled will be sent to one of the four planned incinerators to be built in Guangzhou (Royal Danish Embassy, 2002). While this

Consumption Analysis of Hong Kong and Guangzhou

does reduce amounts of waste and frees up landfills for material that cannot otherwise be disposed of, it creates other types of pollution such as air pollution.

In order to make material consumption sustainable all that needs to be done is two things: use less and recycle more. In the future, Hong Kong and Guangzhou should continue to increase their plans for recycling and increase the amount of materials recycled. Making recycling mandatory would dramatically increase the amount of recycled materials thereby reducing waste.

4.6.5 Food

Hong Kong, like any other city, has to worry about supplying its people with food in a sustainable manner. Hong Kong has a limited effect on sustainability of food due to its minimal local production. However, the production methods used for the food it imports are often unsustainable for certain food groups. For example, there is over-fishing of a large number of areas from which Hong Kong receives its marine and fresh water fish as well as crustaceans. This kind of short-sightedness by the fishermen and the consumers will cause large problems with the production of these fish and crustaceans in the future, if measures are not taken both by the countries receiving this food and the fishermen themselves.

Fruits, vegetables, and other crops are also being produced in an unsustainable manner. The ground water is being over-pumped to water the fields, and water supplies are limited. There is also use of chemicals for fertilization and pest control (International Institute for Applied Systems Analysis, 2001). Using inorganic fertilizers and pesticides, as Guangzhou and many other areas around the world do, creates unsustainable

Consumption Analysis of Hong Kong and Guangzhou

conditions for growing crops. If organic methods of fertilization are used, then the soil becomes fertile through a natural process and becomes better for growing crops. If chemicals are used, then the plant is being treated, but the soil quality declines every time a new crop is planted. The same chemicals have to be applied again, rather than having rich organically fertilized soil as the base for good crops. Also, using this approach for animal feed can change the problem of animal waste into an asset. When using organic feed, 75% of the nutrients in the feed get put back into the soil after it has been excreted from the animal (Maine Organic Farmers and Gardeners Association, 2001). Animal waste would no longer be so large a problem.

Hong Kong is limited in what it can do to promote sustainable food production, but that does not mean it is free of responsibility. There are things that can be done at the consumption level such as being conservative with food and recycling organic wastes so that they can be reused instead of just being thrown away. This organic waste can be composted and used as fertilizer for food production or to produce gas that can be burned as fuel.

Guangzhou's food consumption is more sustainable than Hong Kong's. Their diet has less meat and seafood, which makes what they actually consume more sustainable. Also, a lot of what they consume is produced locally. This does not play a huge factor in being environmentally sustainable (depending on the cultural practices for farmers). The use of fuels and air emissions from transport that are part of importing resources are the biggest environmental impact that is eliminated by local production. However, this local production does give Guangzhou the upper hand in economic

Consumption Analysis of Hong Kong and Guangzhou

sustainability. It creates jobs within the province and makes the province more self-sufficient.

With both Hong Kong and Guangzhou, emphasis needs to be placed on more organic food production, less over-fishing, and keeping or changing to a more sustainable diet.

4.6.6 Conclusions

Because sustainability involves the interconnectivity and communication of neighboring regions, Hong Kong and Guangzhou need to work together to develop more sustainable methods of consumption. Because much of the pollution in the Hong Kong-Pearl River Delta Area stems from lenient industrial pollution laws, the development of legislation rewarding the use of cleaner industrial methods (through tax benefits, for instance) would help encourage such laws to be adopted. Concurrently, Hong Kong owned companies that are based in the Pearl River Delta must acknowledge their role in this area's ecological problems. By doing this, Hong Kong can lead by example and develop a market for more sustainable technologies.

CHAPTER V CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

- Hong Kong's resource consumption is not sustainable. Hong Kong:
 - Has a high population density as well as 17% of its total land area already developed. These two factors combined lead to a lowered standard of living.
 - Cannot sustain its population's needs for water consumption. Only 20% of its water comes from local water catchment facilities. However, water quality meets all WHO standards.
 - Uses too many new materials.
 - Is at the beginning of a transition (to sustainability) phase in which it is using cleaner and more efficient fossil fuels.
 - Has a diet high in protein (meat) which is less sustainable than a crop based diet.

- Guangzhou's resource consumption is not sustainable. Guangzhou:
 - Only treats 40% of its water which leads to poor quality of tap water.
 - Uses too many new materials.
 - Uses crude oil and coal as its main energy resources. These are polluting, and only a limited supply is available.
 - Produces its own food, which is geared towards economic sustainability, however, ecologically its agriculture uses polluted water for irrigating

Consumption Analysis of Hong Kong and Guangzhou

crops and some pesticides and fertilizers, which all negatively affect the food quality.

- Closer cooperation between Hong Kong and Guangzhou is indispensable in ensuring the ability of future generations to meet their needs in both locations.

5.2 Recommendations

Hong Kong has reached a stage in its evolution where 17% of its territory is developed. Consequently, it is becoming crucial for Hong Kong to incorporate renewable and sustainable development in all areas of its planning. On a more urgent note, Guangzhou needs to do the same.

- Ecological Assessments of areas need to be conducted earlier relative to the design of projects. Better records of biodiversity and ecosystems need to be kept in order to track biodiversity change.
- Water conservation campaigns need to be implemented along with more numerous water treatment facilities.
- Increased awareness of the need for recycling must reach the public as well the need to develop a thorough recycling plan, which will lead to less new material consumption.
- The use of more efficient fossil fuels with a progressive incorporation of non-fossil fuel based energy generation will lead to sustainability in energy consumption.
- Organic farming methods and a less meat-based diet will lead to sustainability in food consumption.

Consumption Analysis of Hong Kong and Guangzhou

A consumption analysis is a good indicator of consumption in a given territory. However, in order to complete a more in-depth consumption analysis, much more time would be required. Data acquisition would be easier with a native Chinese speaker to communicate with the Guangdong government. When choosing to compare the consumption patterns of two cities it is important for them to have similar characteristics in population and land area. Holes or gaps in data will arise making comparison between cities difficult or impossible. These gaps in data must be addressed in the report and minimized through additional research.

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Consumption Analysis of Hong Kong and Guangzhou

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Appendix A

Sponsoring Agency Information

The Civic-Exchange is a non-profit organization located in Hong Kong SAR, China. Its mission is to:

1. Promote civic education, public awareness and participation in governance by strengthening civic participation in public life;
2. Undertake research and development in economics, social and political policies and practices to help shape the breadth and depth of public policy debate and so to advance policies that are sustainable, resilient, non-violent, economically efficient, just, participatory, locally appropriate and spiritually rewarding; and
3. Integrate skills and experience across various disciplines including academia, business, politics, finance, technology and the non-profit sectors. (Civic Exchange, 2001).

Our liaison, Christine Loh, and Lisa Hopkinson founded Civic Exchange in September 2000. The Civic Exchange is focused on environmental issues where they advise such projects as the Clean Environment Campaign (CEC). This project is aimed at appropriating funds and creating public and private interest to help clean up Hong Kong's environment.

Consumption Analysis of Hong Kong and Guangzhou

Also the Civic Exchange deals with international relations. They have set up an international relations salon in which people who are interested in international affairs can meet and talk about their views.

Consumption Analysis of Hong Kong and Guangzhou

Appendix B
Work Plan; C-Term

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
1. Meet with Christine Loh set up weekly meeting	xxxxxxx								
2. Schedule weekly meetings with advisors	xxxxxxx								
3. Meet with Prof. Koenig	xxxxxxx								
4. Prepare and do first presentation for classmates and advisors	xxxxxxx								
5. Meet with advisors and liaison and schedule final presentations	xxxxxxx								
6. Gather data through interviews and archival research	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx				
7. Prepare first draft of literature review	xxxxxxx	xxxxxxx							
8. Prepare presentations on methodology of collecting and analyzing data		xxxxxxx							
9. Prepare methodology section and introduction section	xxxxxxx	xxxxxxx	xxxxxxx						
10. Analyze all data collected		xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx		
11. Revise literature review			xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	
12. Make an outline of the results				xxxxxxx					
13. Revise methodology and introduction section				xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	
14. Prepare the results and discussion section and appendices			xxxxxxx	xxxxxxx	xxxxxxx				
15. Conduct follow-up interviews				xxxxxxx					
16. Prepare the conclusions and recommendations section					xxxxxxx	xxxxxxx	xxxxxxx		
17. Revise results and discussion and appendices						xxxxxxx	xxxxxxx	xxxxxxx	
18. Prepare acknowledgments and executive summary							xxxxxxx	xxxxxxx	
19. Prepare web page						xxxxxxx			
20. Finish final proposal							xxxxxxx	xxxxxxx	
21. Prepare final oral presentations							xxxxxxx	xxxxxxx	
22. Present final presentation									xxxxxxx
23. Head weekly meeting with liaison and advisors	Maureen	Ben	Jeremy	Keith	Maureen	Ben	Jeremy	Keith	

Appendix C

Interview Protocol

This is a general interview protocol. Two students will attend each interview, one will take notes and the other will conduct the interview. Initially, we will thank the interviewee for taking the time to spend with us. We will then ask questions like: How are you? Once we feel that the interviewee is comfortable we can move on to more pertinent questions.

Introduction Statement:

The project is concentrated on forming a consumption analysis for Hong Kong as well as assessing the resources that Guangzhou provides. We understand a consumption analysis to be a measurement of the resources consumed and waste produced by a defined population. This can include the impact that the production of resources and waste used by one area has on other places around the world. In doing this project we hope to help predict the future need for resources as well as the growth of waste produced. Hong Kong is one of the most densely populated areas in the world and in the past has been highly industrialized. The studies done by Friends of the Earth (1996) and Prof. Koenig (1997) regarding the Ecological Footprint of Hong Kong, show that Hong Kong uses well over what it produces. The goal of this project is to get an up-to-date study, to find whether Hong Kong's ecological impact has grown. The study will be broken down into 5 sections (food, water, energy, materials, urban). (We would also like to talk about any of the current data that we find, in order to get feedback and suggestions on the project.)

Consumption Analysis of Hong Kong and Guangzhou

Questions:

- 1) Can you please describe your background (as related to this project)?
- 2) Has your previous work involved any ecological footprint or consumption analysis studies?
- 3) Based on the guidelines of our project and the area (Hong Kong and Guangdong) on which it is concentrated, how would you suggest breaking down the consumption patterns?
- 4) In terms of our definition of a consumption analysis what steps would you follow to do a study similar to ours?
- 5) Where would you look for resources (books, web pages, people, journals, etc.) to supplement this type of study especially focusing on Hong Kong and Guangzhou? (based on the categories in which the study has been broken down)
- 6) What approach would you suggest to analyzing the data that we have collected? (What sorts of questions should we ask in order to obtain the information we are looking for?)
- 7) Based on the information we have currently, what predictions can you make about the resource consumption and the waste production of Hong Kong and Guangzhou?
- 8) With the predictions that can be made what suggestions do you have to correct any over-consumption of resources or over-production of waste?

Consumption Analysis of Hong Kong and Guangzhou

The interview with Professor Koenig will include the questions above and the following questions.

- 1) Is there enough public information on Guangdong to do an ecological footprint study?
- 2) What government sources could be used for this study and where could they be found?
- 3) What other professors would you recommend talking to at the University of Hong Kong or other universities?
- 4) In “Hong Kong’s Urban Metabolism and Ecological Footprint 1971 – 2000” it is stated that Hong Kong receives 698 million m³ water from Guangdong and 224 million m³ from rainfall in 1997. How can you account for this 9 million m³ of water?
- 5) Also in the same paper in the Food section, there is no percent value for the vegetables consumed, how does this fit into your calculations?

Conclusion:

Thank the interviewee for the interview as well as ask for a possible follow up interview.

Appendix D

Interview with Prof. Phil Robakiewicz

Interviewers: Maureen Foley and Keith Stone

Interviewer: Our project is concentrated on forming an Ecological Footprint study for Hong Kong and Guangdong. We understand an ecological footprint to be a measurement of the resources consumed and waste produced by a defined population. This can include the impact that the production of resources and waste used by one area has on other places around the world. In doing this project we hope to possibly help predict the future need for resources as well as the growth of waste produced. Hong Kong is one of the most densely populated areas in the world and in the past has been highly industrialized. Recently Hong Kong has moved much of its industry north of the border where the Guangdong Province is. This has caused fast industrialization in this border region affecting the ecological footprint of Guangdong and Hong Kong. (We would also like to talk about any of the current data that we find, in order to get feedback and suggestion on the project.)

Interviewer: So what we wanted to do is get a basis on what you think we could do with our project.

Prof. Robakiewicz: One thought off the top of my head is to check into Singapore. Have you looked at Singapore?

Interviewer: No, we haven't.

Consumption Analysis of Hong Kong and Guangzhou

Prof. Robakiewicz: Singapore has done a remarkably good job of becoming an industrial age city, while still preserving a good deal of the native environment and preserving resources. That might be something to look at sort of comparatively. How have things been done in Singapore in terms of something that works correctly. In terms of actually assessing an ecological footprint you are clearly not going to be doing it by hand. You will be accumulating it by secondary sources?

Interviewer: Yes.

Prof. Robakiewicz: So a lot of that is really going to boil down to how accessible those sources are. It will be an issue of trying to accumulate those things from Chinese government sources. Hong Kong's government is British so all the history from which this comes is British so their recording keeping is good. In China I would be concerned about finding information. Which is why I was thinking about Singapore because in the same way as British colony they have excellent recording keeping.

Interviewer: Has Singapore done assessments like this in the past?

Prof. Robakiewicz: I would presume so. The other thing that you might want to look at, which would be getting to be kind of an MQP actually would be to get some satellite images.

Interviewer: Yes, our advisor suggested using GIS.

Prof. Robakiewicz: You know that is a huge amount of work.

Interviewer: To get the images?

Prof. Robakiewicz: Well to get them and interpret them and figure out what to do with them.

Consumption Analysis of Hong Kong and Guangzhou

Interviewer: Well, I don't understand GIS so what sort of information could we get that would be useful to our project?

Prof. Robakiewicz: The way I think GIS is easily defined is that it is a bunch of computer generated transparencies. Where each transparency is a different thing. Like, the river system, the number of trees, the human habitations, a whole bunch of things so when you stack the transparencies together you can see where the humans overlap the trees or where the rivers are near human habitation. Those things are also done for much more physical things like in the United States for the per capita income and they'll plot it out physically on a map. So you can see: Well do people who have the highest income live in the flood plains or on mountaintops? You could ask those kinds of questions. But the GIS requires two things, first that the data has been collected and secondly that it has all been entered into an existing GIS. You can get that information for most of the United States but for Hong Kong, I don't know. You can do on your own a GIS type of analysis, even if it were actually something as simple as finding maps that gave you that kind of information and then transferring them to make sure they were the same size and then actually comparing them on a transparency. I think the place you should probably start is watershed, that the clearest delineated area as we talked about in Ecological Management. You could really figure out where the inputs into the water systems are because if you don't have water you don't have humans. You have to figure out where there major water sources are, which may be in the Guangdong Province. So once you figure out where those water reservoirs are, you figure out what sort of stream sources feed in that reservoir and then figure what that ecological footprint is there. That is probably going to be your biggest of the footprint pieces. The other one that is

Consumption Analysis of Hong Kong and Guangzhou

sometimes huge is an electrical or energy source. The energy sources could even be tied in with some of the water resources. You know for really industrialized, incorporated nations like the United States, in Massachusetts the energy footprint actually extends into Canada. There are rare times when we buy Canadian fuel. So where are they getting the coal or the wood that they are using or where are their hydroelectric dams? Then you have to add the watershed of the hydroelectric dam to your footprint. Those things tend to get really huge. In Hong Kong I imagine it will be more localized than that. So think about watersheds, there should be some amount of information on that even in the pretty rudimentary record keeping system, people usually do keep track of where the river are, where the population center are along the rivers and where they feed into.

Interviewer: If they do not have GIS information for Hong Kong, we could create a population density map. Where we would do it from 1997 to 2000 to see how the population has spread.

Prof. Robakiewicz: Sure that would give us some idea of how it has changed and what impact that might be having. The other thing you can do with GIS is that it is also a dynamic system. Say, 45 years from now given this rate of consumption and this rate of growth what are these parameters going to make the map look like. Clark University is sort of the national sources for GIS. In my opinion you'll be turning your project into an MQP in Civil Engineering if you start going too far down that route. But using those basic concepts, think of the transparency overlays.

Interviewer: Hopefully, we will be able to find that sort of information on Hong Kong. Now I have some other questions to ask you. Can you please describe your background in ecological science?

Consumption Analysis of Hong Kong and Guangzhou

Prof. Robakiewicz: Sure, there is my Ph.D. , I have studied ecology most of my professional life on some level and then I worked for the Massachusetts Audubon Society for a post-doctoral position for a couple of years. So I know something about government regulations and applied ecology as well as academic ecology.

Interviewer: Yeah I got that from your web page. Has your previous work involved any ecological footprint studies?

Prof. Robakiewicz: No it hasn't my research and interest focus has always steered away from human ecology. The way you are defining an ecological footprint here you are talking about human resources. So I have studied watershed ecology from the standpoint of organisms that use the watershed, but have excluded human resource use. I have not studied ecological footprints in the definitions we have here.

Interviewer: Okay great. Have had you seen studies like this before?

Prof. Robakiewicz: Yes, you see this thing cropping up all the time. It's usually done as a social science piece not as a biological science piece.

Interviewer: From our viewpoint a lot of it is going to be to based on economics.

Prof. Robakiewicz: Right, the times when you see this sort of stuff you see them in journals that are largely looking at social sciences.

Interviewer: Is that something we should be looking at?

Prof. Robakiewicz: Yes you should, there are some things on the basic BIOSIS from the Gordon Library page and under that there is an option called ECO. That has a lot of sociological oriented journals that relate to environmental issues.

Interviewer: Actually we are looking for ecological footprint studies done in other areas. Do you think that site would have something like that?

Consumption Analysis of Hong Kong and Guangzhou

Prof. Robakiewicz: Well some other keywords that you could look for are “ resource use patterns” or “watershed ecology” that sort of stuff. Where footprint may be a buzzword and something I haven’t heard often, so you may want to try other things.

Interviewer: Okay we’ll look into that. The next question is, based on the guidelines of our project and the area that it is concentrated on what factors would you suggest concentrating on? You already mentioned watershed, so that is the factor main factor you would suggest concentrating on?

Prof. Robakiewicz: Yes.

Interviewer: Okay Do you think an ecological footprint is more concerned with local resources or greater scale ecological problems meaning problems that effect the entire earth.

Prof. Robakiewicz: I would say more the latter. I think when you begin to put together one of these things, you collect your data on a local scale, but then you scale up what you have looked at. The fundamental issue of course boils down to when you have people living in large urbanized centers who don’t produce any of their own resources, What’s the effect on the more global environment (What are the stresses from that?)? So if you lived in New York City everything you get is produced elsewhere. So it’s a huge amount of humanity that is making a resource use that is completely separate from where they live.

Interviewer: If you did a more of a global scale project would it give an estimate of the economic effect?

Prof. Robakiewicz: Well I think that the issues are global but the questions should be local.

Consumption Analysis of Hong Kong and Guangzhou

Interviewer: Okay well if you were to do a project like this in terms of our definition of an ecological footprint what steps would you follow?

Prof. Robakiewicz: I think I would try to get a handle on how much this information is available in Chinese government documents or non-governmental documents. Know that up front because otherwise you are going to put together a plan that's going to be completely undoable because the data simply aren't available and you can't collect it yourself. Let's assume those things are available the next thing I would do is decide one of two things whether you want to look at a subset of environmental variables that have the greatest impact or whether you have a subset of environmental variables that you or the sponsor have a specific interest in. Water is certainly going to be one of those things but if your sponsor might want you to look at something completely different like agricultural impacts. You are definitely going to have to pare this down to a few resources.

Interviewer: Well we actually broke down our project into section like water, food, materials and a section on urban. For a general outline of an ecological footprint study would you think that would cover enough to get a good assessment?

Prof. Robakiewicz: Yes, definitely. You are not going to have a problem with broadening your scope you're going to have a problem with focusing. Waste is another huge section. This is a nice approach "let the record show that the professor is indicating Figure 5 on page 9). This overall energy flow diagram where as many as these sort of pieces that you can put together to make into an integrated chart. A really nice way that you can display this is to make your arrows reflect their relative amount by their thickness. That is a real nice dynamic way to present this information so you can see

Consumption Analysis of Hong Kong and Guangzhou

where the important inputs are. You might find many inputs and then find that a lot of them are fairly minor and you don't want to decide that there is a cutoff where you decide not to include something. So it could be represented as a dotted arrow so that whoever looks at it next will know right up front that while you identified it as a source its one that's not going to be very important. Are you by any chance going to be looking at this from a sociological standpoint? Where people will actually be asked to value in some way how important clean water in some way verses clean air verses waste management verses owning a car that kind of stuff.

Interviewer: No we won't really be getting into that.

Prof. Robakiewicz: Okay that's fine. That may be something another group could look at in the future with the same sponsor.

Interviewer: Well maybe that could be something we could suggest in our discussion section, human evaluation.

Prof. Robakiewicz: Yes, human conception and contingent evaluation.

Interviewer: Another question would be that if you were writing an ecological footprint paper how many different objectives would you suggest getting. As in interviews and other sources to have a valid study?

Prof. Robakiewicz: When the IGSD runs these things they have some sort of standard format that they are looking for. The more sort of scientific the question gets the worse their guidelines fit it. And this is beginning to get pretty scientific. When you are doing like marketing sort of stuff you are definitely going to want to have many peoples opinions on this. What you guys want to be doing really is collecting facts.

Consumption Analysis of Hong Kong and Guangzhou

Interviewer: So it will be a lot of research data? We will be doing some interviews as a resource on where to get more resources.

Prof. Robakiewicz: Yeah, and when you are on site you are certainly going to want to interview people who are in position of power related to this stuff, people in the Ministry of transportation, energy or natural resources. Talk to your sponsors and see if they have people they can contact for you, to just get an idea of the ground truth, some of the trends you might be seeing. Do you have any real legislation that you're planning on putting together in the next few years that are addressing these problems? Those are things that you might want to interview about while you are there on site. But with this sort of general question of what is an ecological footprint? I think you want to find support for that in the existing scientific literature not by asking people. Have you looked at the references in this paper (Referring to Koenig study)? There are also a couple papers in here that might be relevant. Koenig has another paper referenced here; there is one on water science technology about waste management. Are you going to go into the marine environment or is this going to be a terrestrial study?

Interviewer: I think we are going to take that into account like when it applies the terrestrial aspects such as food consumption.

Prof. Robakiewicz: Well I was going to suggest you separate those two things out because clearly there's a huge oceanic impact but that's another whole can of worms. Marine resources are usually considered a separate thing from fresh water resources, so I wouldn't delve that much into the marine resources.

Interviewer: Well those are the questions I had for right now. If we have any further question could we schedule a follow up interview at a later time?

Consumption Analysis of Hong Kong and Guangzhou

Prof. Robakiewicz: Sure, just email me.

Interviewer: Thank you very much for spending the time with us, it was very helpful.

Appendix E

The Interactive Qualifying Project

The Interactive Qualifying Project (IQP) is a project that is based on examining the interactions between science, technology and society. Because WPI is a scientific and technologically based institution, the IQP gives the students an opportunity to understand how their future careers may affect society. An IQP should support the surrounding community promoting its advancement through the appropriate use of science and technology.

Hong Kong and Guangzhou's societies and growing technology have added to its large resource consumption. This project is aimed at producing a consumption analysis for Hong Kong and Guangzhou. The results of this study will allow for suggestion on ways to reduce resource consumption and waste production.

Appendix F

Interview with Eric Walker of Friends of the Earth
Interviewers: Ben Adamo and Maureen Foley

Eric Walker (EW): I took off on this project from the literature of Bill Reese and Wackernagel as the basis. I didn't apply the exact model that they had. I added water, I didn't do the adjustments they had for productivity because it didn't make much sense. One reason for doing that was because I wanted this to be a clear decision making tool for people higher up and if you start adding coefficient that come out of nowhere and are hard to explain that's self defeating. I have done it a certain way that makes sense to me but you can't compare it to the ones that are done internationally. That is the big challenge for in making it a media issue because people want comparisons.

Interviewer (I): We haven't found much for Guangdong yet do you have any suggestions on where to find information of Guangdong?

EW: I am not the one to talk to about that. Hong Kong has a lot of data, with the port and historical data. The problem with statistics here is that sometimes it is difficult to differentiate between things that are just passing through as opposed to things that are actually imported and used. It is not always clear which this are semi-manufactured come in get altered and export to somewhere else. I did a few checks and balances on the statistics of what is going to the landfills, the EPD has on their web page an annual landfill survey which gives you a rough idea of what is going into the landfills and then you can fill in with what they estimate for recycling. What we know of recycling those numbers are understated. So then you have to approximate because you know that a number maybe up or down. So there is always a challenge in trying to balance real numbers.

I: The way we are approaching our project is to try to have a comparison of Hong Kong and Guangdong in which we use the most recent numbers we can find and also looking at economic trends with Guangdong and trading. We would like to do this by analyzing the interaction between the two.

EW: Well even in Guangdong you are going to have a huge difference between the urban centers of Guangzhou and Shenzhen compared to the interland. There will be a big

Consumption Analysis of Hong Kong and Guangzhou

difference in comparing the villages that basically run on their own compared to the nevous riche. Hong Kong is such a small area you can basically homogenize everyone. The challenge now is looking at where things were produced. It is not a concept that is well explained in the mainstream.

Hong Kong is basically diverting a whole river, getting water from Guangdong. What if we just did water recycling locally? That is coming around again. Originally there was a desalination plant in the 70's in the 80's when the oil crisis hit, prices went up and they shut it down. In 1983 actually was the last time Hong Kong had water rationing, so its within fairly living memory that Hong Kong has been challenged to meet its water demand. After the opening up of the mainland, Hong Kong has relied on water from there. But ultimately we have country parks, to catch rainwater.

The area that has to be dealt with is how you provide the technology, to lower impact. One area that you might want to focus on is energy. Guangdong is very far ahead of, Hong Kong in terms of energy in thinking and policy. They had a conference in Guangzhou a few weeks ago about wind power concession area, so Guangdong wants to initiate a concession model where they set aside a concession area and have an auction for companies to come in and build a large wind farm. That is because they want to kick start the local industry and bring down the prices of renewable energy. They also have an innovative project on the Pearl River Delta where they are turning the pig waste from pig farm through anaerobic digestion into bio gasoline and fuel cells. Hong Kong is still fighting for money, you know by joining the WTO. They don't want to try that stuff because they don't believe there is a problem.

I: It seems that the process in the government is very slow and the lines of communication are not open. There seems to be very little action.

EW: Well it's slow. In the case of energy, there is a scheme of control which is how the utilities are regulated, which is a profit scheme the utilities came up with initially and the government has been used to just approving that every few years. We have more people we need a new power plant so it's built. If you try to put in renewable energy, it doesn't work, because the government sees no reason to change things because it works. In terms of energy there is the Environment and Food Bureau which looks at the environmental impacts and the Economic Services Bureau which is the policy bureau for

Consumption Analysis of Hong Kong and Guangzhou

energy, two policy bureaus, they are separate, one will look at providing cheap energy and the other will look at the environmental impacts and there is basically a brick wall between them.

And then there is pollution, and we are trying to figure out what percentage is from Guangdong and therefore it seems whatever Hong Kong produces is only a small percentage.

I: It seems that there is a lot production for Hong Kong in Guangdong, which causes a lot of the pollutants, and that has to be taken into account as well.

EW: Well yes, and many of the companies up there are own by people in Hong Kong. How are you planning to do this project are you planning on comparing two years?

I: Yes, we would like to compare the most recent data, especially after the turn over to China and also try to put the information on a web site.

We are hoping to get advice from you on where would our energies best be focused in the time we have.

EW: If you already have to background, the key is having the right documents on hand. It is still a lot of manual labor to go through, a lot of number crunching. But what I never got to was describing the change of technology, because this is really just a tool to describe what happens when you change technology. My feeling is that in the main stream when you present something like this it is taken to be, that it is just how it is. It should be used as a snapshot, that can be used and that is changing, even within the present situation.

At this point maybe if you have limited time, you could do an economic modeling and make a very strong correlation between GDP energy use therefore you could expect the energy footprint to be so much. Then leave that very simple but then look at the technology options. That would be exciting to people.

I: Well, at the end of the FOE study there is a section that suggests different ways to improve the environment with technology.

EW: Yes the eco-city idea, I thought that was necessary because if you do it piece by piece that's the typical government thinking, but if you put it together then there is the idea that there might be a nicer community too. The thing that cannot be over stated especially for Hong Kong is that we think we are not big enough. Like when I compared

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong to Switzerland people just don't believe that the ecological footprint is the same, but the population is the same. People don't believe that the impact is so big, especially in modern time, because you don't see any of the production process.

The fascinating thing to me is showing that there is a range of technology options that could change your footprint and making the connection to actual situations, places and people. It is a very big realization to see where everything comes from because it makes it real. Most of this is just way too extreme for some people but if you reduce it down, to following a resource back to its origin and then you make all the connections to the people involved and their health, environmental and social impacts, you have a picture of a family on the other side of the planet. You just want to get people to understand the big picture. If you want to put this information on website, it would be good to add that human element. It would be good to add actual pictures of where things come from. If you have limited time, coming up with a number that is 20 percent larger than the last number won't have the impact, (it would be important) but it won't help in going further from that point. People just have a different idea here of what democracy and freedom, which is the right to make money, not concern for the environment or personal responsibility. Like the petrol diesel switch in taxis didn't work, they don't want scapegoats who are the first to have money taken from their profit margin to clean up the air, that's why it failed. Because those people believed it was a free place and they don't have to be victimized as the ones to clean up the air.

I: I thought that was actually working out.

EW: Well eventually, but its been years though. And if you look at the progress of it its been decades. If you look EPD stuff, several years ago it was still very clearly in their terms of reference that development has to go first, pollution will be created but the profit made can clean up the pollution. Its very clearly stated, but I don't see that anymore where we can initially start without polluting. So yes, decision making is in compartments, there is no conviction that changes has to happen. But now there are green groups like the EPD that are coming up with numbers, which says the air pollution is costing this many millions. But the question is not asked should we still subsidize diesel, even with the health cost? You need public pressure to get the government to change things, which can be done with a human element. You need to get people to

understand the footprint approach, and then follow back to where the resources came from and show where things come from and who makes them.

One problem is people don't know what fresh air is. We did a survey and one question asked was, have you ever stood in a forest and breathed fresh air? And over half said no. So to some people this polluted air is normal. It is hard to contrast when a lot of people don't know the difference.

There is also a problem with preservation here, where if you find valuable land with a lot of biodiversity then it should be preserved. Areas that have a possibility of having that biodiversity are preserved. There is not much knowledge of what the value is, so areas with the most of some species is fenced off and protected. But there is not a connection of what ecosystems are actually keeping alive.

But making that connection is what is important, doing a footprint would be interesting to people like us, but it wouldn't help to get people involved.

There are a number of labor groups like the NGO that deal with working conditions in places like China. They could give you information on how things are produced and the actual social and health problems related to the production. People don't think about where things come from, like when they buy things that are very cheap. That would make the connection for the government and the public as well because they could both relate to that.

If you can go beyond the theory and do the case studies I think it would be far more relevant.

I: What steps have Hong Kong taken toward solar energy? How feasible is it in Hong Kong?

EW: Well solar PV, there are a couple issues and one is the cost. The problem with PV is that it usually the cost does not compare to the peak cost, which is offsetting. So PV is always producing in the middle of the day which in Hong Kong is always peak cooling time, you know when people are running their air-conditioning. So it should be compared not to the average price but the peak price. Which no one sees on their bill here. If we actually had time of use tariffing where people actually saw a different tariff at different times of the day, but it is just so hard to get that past utilities. Now the debate is about grid connection. And utility companies are all for the solar power but then

Consumption Analysis of Hong Kong and Guangzhou

you've got to have a million dollar switching gear system that isolates your system in case there is a power failure. Utilities are not into the idea of taking that power. I think for Hong Kong, it would be useful because there is so much urban area you could put it on. It would be close to the load but you would have to have a census for it and you have to have protection for it. Because here the spacing between buildings is a few inches, so if you are going to invest in PV and then someone goes and puts another building next to your that is really high up you have lost your investment. None of that is in place yet. Right now there is only pilot projects. Right now in most parts of the world it's a complimentary system, where in the summer you have high solar input and low wind and in the winter there is high wind input but low solar. The issue will come to how you issue a variable power on demand. You should look into the NETA New Electricity Trading Agreement in the UK where you have to produce what you say you will produce. If you go under then there is a high penalty and wind power was really hit hard. One response to that was the wind projects teaming up with landfill gas projects, the landfill gas you can attenuate, to match the wind so you can get a complimentary output. But these examples illustrate the problem, which is, how do you deal with variability.

Appendix G

January 21, 2002

Interview with Ms. Amy Cheung, Senior Town Planner – The Planning Department

Interviewers: Keith Stone, Jeremy Graef, and Maureen Foley

- Provided the 2030 Planning Study (both stages 1 and 2).
- Buildings have a usual life span of 30 years, before they are rebuilt. The reason for so many tall buildings is to fit the large population in such a small area.
- Two options for future planning (housing) building in the urban area more or building in the New Territories. No one wants to live in the New Territories because it is too far from the city i.e. jobs.
- Possibility of turning old industrial buildings into flats for more housing.
- EIA's done before a development is built, but if the EIA presented something ecologically important and there was no other place to move the project, the development would continue in the same area.
- Getting public involved in land planning, we were invited to the Land Planning forum on Jan 26, 2002.

Appendix H

Meeting with economist Stephen Brown

Hong Kong and New York and London have relatively the same Population and gdp so there is no reason why they can't have relatively the same amount of pollution. So then you have to ask yourself what are the differences. The industry as you know has, in the past twenty years moved across the border. Until recently there were no regulations on dumping stuff over the border. That is a basic thing and then you look at why any society can incorporate pollution laws. You can argue that you have an undemocratic society where the taxi drivers and the truckers have disproportionate political influence behind the scenes it can be quite difficult to fo on to a system where by. can't hear end of sentence.

The gov't however has a policy where they want to keep traffic moving at 15km/hr or whatever their yardstick is and they build enough roads to keep traffic moving at 15km/hr. Now, the stupidity of it is the more cars you have, the more roads you build rather than saying that these roads are not charged for in Hong Kong they are just given away and there fore you are just inciting people to use roads because you are not charging for the trucking or whatever so you have a fundamental unresponsiveness in gov't because there is nothing for them to be responsive to. They have no way of judging if this is an issue whether it should be an issue because of their lack of say in government. If you don't have a democratic society, there is no political platform for people to express their views. Education about green issues is very important. The gov't just gives bullshit surveys that say "do you like cars" and the response is yes so the gov't says alright, people want more cars.

Maureen: Well it doesn't seem like anybody is saying anything.

Brown: Well nobody knows is the answer. There isn't a mechanism to make that judgment. If you work for the transportation department, your job is to build roads. If you're on the transport department and you aren't building, what are you doing? They've been building and they will continue building. It is the some as the housing department here, they have been building houses for 50 years and they can't stop because they don't

Consumption Analysis of Hong Kong and Guangzhou

know what else to do, and also there is a lot of corruption involved. One of the reasons to stop building houses is to get rid of potential opportunities for corruption. So you have this gov't with an inability to lead the people forward. One of the major reasons why our pollution is so high is that we have one of the world's largest container ports and London and New York do not. Do you need a container port in the middle of a service sector economy with the amazing number of container lorries that come down when Southern China has two large container ports, which Hong Kong owns anyways, we control them. Hong Kong essentially owns Southern China with our capital and now we are starting to own Eastern China and Shanghai. Somehow we still insist on shipping 18 million things a year through Hong Kong. The actual process of putting that box on the lorry, that lorry coming through Hong Kong using industrial grade diesel, causing traffic jams, getting stuck in traffic, you have to look at whether that is a cost or a benefit. The actual process of putting that box on the lorry in America is a very low value added process while in Hong Kong it is considered essential to the economy. If you are going to have these lorries at all you have to make sure that you tax them and that they are regulated and that they are using high grade diesel which is cleaner burning.

Maureen: asks second question, how much is going to be to clean the pollution, public perception

Brown: it will be helpful but the methodology would often be skewed because if they come out and say that the container lorries and the pollution standards are far to low then that screws up the transport department and the highway department and it is getting even worse with this new guy in charge of Hong Kong because he has a sort of Japanese port barrel spending to create jobs. The emphasis now is on building roads for the sake of building roads to create short-term construction work so that the people coming over from China with no education can get jobs because it is the only thing that they can do. They come over for the jobs and the free housing and free education. Now we are just building roads to give these guys jobs and it is a vicious circle. The main problem is that China and Hong Kong believe the GDP is the yardstick of economic progress and so there is a high rate of GDP but it is not very intelligently use. You need other indicators

Consumption Analysis of Hong Kong and Guangzhou

to see how well your economy is doing rather than just how much money is spent in the economy every year. It is actually a retrograde step.

One of the problems in Hong Kong is that the gov't controls all of the land; there is no free hold land so private contractors control the land so they never have to go to the legislature. If I actually want ten dollars I have to go through the budget and ask for a check for 10 dollars and they can debate it but if I want to give you 100 hectares of land I can give you 100 hectares of land on signature and that is non-taxed non-budgeted item. The easiest thing for the gov't, historically to have done because it wants to achieve a name is to use land and to use remote lands to build roads and to build new towns and they don't have to ask anybody. It can give land to the housing authority, the housing authority has money, it starts building houses, and then you need some roads. Then they go to legislature and say "We have all this housing, now we need some roads".

Maureen: "What are your thoughts on developing the new territories?"

Brown: They have developed a lot of it. If you look in the early 70's, it has always been easier for the gov't to move to new areas rather than re-develop. In the mid-70's the gov't decided to set up a low income housing to take people in from decaying urban areas and to handle growing population and then the vicious circle of now you need roads because you have these houses starts. Now because we are dealing with a socialist gov't, they make 6 or 8 towns, and the majority of the people in Hong Kong now live in the New Territories, but of course you end up with the poorest, least educated, and the most socially excluded people living in these new towns. They are the have-nots. There is hardly any work there because in a service economy you do not want to employ these people. So you have an area with all low-income people and then you build a school and you end up with the worst teachers, the worst students, they never come into contact with anybody else. Because of the way that housing works in Hong Kong, if you have a cheap rental flat and there is a job in Hong Kong Island, you can't move and you are stuck.

Maureen: Do you know how much economic information is available in Guangdong?

Consumption Analysis of Hong Kong and Guangzhou

Brown: There is quite a lot. Although you can be a bit tongue in cheek about the statistics because they don't have a proper price index. IF you look on the web you can find a lot but you may have to pay like 500 Hong Kong dollars. The best place to look is in the yearbooks.

Appendix I

January 23, 2002

Interview Notes with Mr. Damien Ku and Ms. Daisy Ho of the Water Supplies Department

- Many of the numbers needed to calculate the water consumption of Hong Kong can be found in the Water Supplies Department Annual Report for 2000 – 20001 and also on the Water Supplies Department web site.
- Hong Kong gets about 70 percent of their water from the Guangdong Province, specifically from the Dong Jiang River.
- Hong Kong reserves a large percentage of their water in reservoirs such as the Plover Cover Reservoir and the High Island Reservoir.
- The Hong Kong water supply is very clean. It meets all of the WHO regulations, numbers can be found in the annual report.
- Water consumption has decreased since the industrial movement to China, so the annual consumption is less.
- Water Conservation – The WSD has put in acoustic detection systems, that can find leaks quickly so that it can be repaired and water is saved. The water pressure in the pipes is also monitored so that at night when there is less usage the pressure is decreased. (Some water mains are not under the jurisdiction of the WSD so they can not control the maintenance of them.)
- There have been negative reports from the media about the water quality in Hong Kong, the water is in fact very clean, but one problem may be the pipes. Many of the old building have pipes made of ungalvanized steel, which rusts easily. The WSD can only suggest buildings owners to change the piping in buildings to galvanized steel pipes or polyethylene pipes.
- The use of sea water for flushing saves 20 percent of the potable water in Hong Kong.

Consumption Analysis of Hong Kong and Guangzhou

Appendix J

Guangzhou Material Data from Statistics Bureau of Guangdong

Total Industrial Production 1999 (Yuan\$10000)	Total	City		HKD	HKD(mil)
Black metal mining and transport	3047	3047	30470000	28743691.68	28.74369168
non-metal	384558	23073	230730000	217657761.1	217.6577611
other metal	44048	2678	26780000	25262752.32	25.26275232
wood and bamboo	11270	89	890000	839576.16	0.83957616
Weaving	975523	318312	3183120000	3002777153	3002.777153
Garment	1723465	351458	3514580000	3315457956	3315.457956
leather *****	1764821	701395	7013950000	6616567649	6616.567649
wood, *****,bamboo	329192	76730	767300000	723827851.2	723.8278512
pulp and paper	682686	378188	3781880000	3567613807	3567.613807
chemical (raw material and chemical products)	2083523	1456315	14563150000	13738060174	13738.060174
rubber products	382044	121066	1210660000	1142068847	1142.068847
plastic products	995043	400577	4005770000	3778819095	3778.819095
Vital Industrial Production 1999					
wood(m3)	68761				
textile(metric ton)	12177				
cloth(10000meters)	9335.37				
machine made paper(metric ton)	501009				
newspaper roll(metric ton)	168212				
plastic(metric ton)	68825				
plastic products(metric ton)	346767				
Guangzhou Imports Exports 1999					
Import Export total (US\$10000)	2277651	22776510000	1.77625E+11	177625.1187	
Import(US\$10000)	1239800	12398000000	96687166780	96687.16678	
Export(US\$10000)	1037851	10378510000	80937951871	80937.95187	
Guangzhou Imports/Exports to Hong Kong 1999					
Import Export total (US\$10000)	399647	3996470000	31166910907	31166.91091	
Import(US\$10000)	69998	699980000	5458871028	5458.871028	
Export(US\$10000)	329649	3296490000	25708039879	25708.03988	

Consumption Analysis of Hong Kong and Guangzhou

Appendix K

Hong Kong Material Data from Census and Statistics Department

				Total Counted Materials
Imports	1991	1994	1999	
Crude materials, inedible, except fuels (\$million)	19718	23816	21981	111922
Chemical and related products, n.e.s. (\$million)	60806	84122	89941	
Manufactured goods classified chiefly by material (\$million)	182443	259536	249758	
Machinery and transport equipment (\$million)	227440	443633	540679	
Miscellaneous manufactured articles (\$million)	212468	337549	388999	
Commodities and transactions not classified elsewhere (\$million)	2899	4714	3637	
				Total Counted Materials
Exports	1991	1994	1999	
Crude materials, inedible, except fuels (\$million)	1958	1818	1496	7151
Chemical and related products, n.e.s. (\$million)	7482	8418	5655	
Manufactured goods classified chiefly by material (\$million)	27859	26455	15623	
Machinery and transport equipment (\$million)	59550	62211	39731	
Miscellaneous manufactured articles (\$million)	123883	112472	103114	
Commodities and transactions not classified elsewhere (\$million)	3440	3906	1512	
				Total Counted Materials
Re-exports	1991	1994	1999	
Crude materials, inedible, except fuels (\$million)	13160	15677	17792	84743
Chemical and related products, n.e.s. (\$million)	38026	56731	66951	
Manufactured goods classified chiefly by material (\$million)	105499	165653	189740	
Machinery and transport equipment (\$million)	137255	304789	431637	
Miscellaneous manufactured articles (\$million)	211329	361579	440260	
Commodities and transactions not classified elsewhere (\$million)	1444	2936	2510	
				Total Counted Materials
Imports and Re-exports by End-use Category	1991	1994	1999	
Consumer goods - Imports	306432	514173	508354	
Consumer goods - Exports	290726	498437	545322	

Consumption Analysis of Hong Kong and Guangzhou

Raw materials and semi-manufactures - Imports	293057	431768	471854	
Raw materials and semi-manufactures - Exports	155266	264288	343009	
Capital goods - Imports	122745	228851	327933	
Capital goods - Exports	72141	161582	268630	
				Total Counted
Domestic exports by destination - Mainland China	1991	1994	1999	Materials
Articles of apparel and clothing accessories (\$million)	2529	4702	16332	4747
Electrical machinery, apparatus and appliances, and electrical parts thereof (\$million)	4334	5130	5303	
Textile yarn, fabrics, made-up articles and related products (\$million)	7523	6660	4231	
Parts and accessories suitable for use solely with office machines and automatic data processing machines(\$million)	1345	2151	2123	
Printed matter (\$million)	680	749	752	
Telecommunications equipment (\$million)	7946	8497	2981	
Watches and clocks (\$million)	3070	2876	1257	
Articles of plastics (\$million)	1745	1500	516	
Baby carriages, toys, games, and sporting goods (\$million)	1555	1394	438	
				Total Counted
Re-exports by Destination - Mainland China	1991	1994	1999	Materials
Electrical machinery, apparatus and appliances, and electrical parts thereof (\$million)	11321	23713	58938	59825
Textile yarn, fabrics, made-up articles and related products (\$million)	35620	56012	59825	
Parts and accessories suitable for use solely with office machines and automatic data processing machines(\$million)	2796	7298	17577	
Telecommunications equipment (\$million)	6010	20111	32135	
Watches and clocks (\$million)	3055	5507	4237	
				Total Counted
Re-exports by Origin - Mainland China	1991	1994	1999	Materials
Articles of apparel and clothing accessories (\$million)	61934	90146	94472	42487
Electrical machinery, apparatus and appliances, and electrical parts thereof (\$million)	16922	38512	76835	

Consumption Analysis of Hong Kong and Guangzhou

Textile yarn, fabrics, made-up articles and related products (\$million)	30091	37888	42487	
Parts and accessories suitable for use solely with office machines and automatic data processing machines(\$million)	2039	11712	37453	
Radio-broadcast receivers (\$million)	17586	28919	21132	
Telecommunications equipment (\$million)	9161	23219	48441	
Watches and clocks (\$million)	6053	11683	19053	
Travel goods, handbags and similar containers (\$million)	18506	28333	31925	
Footwear (\$million)	23815	51949	46530	
Baby carriages, toys, games and sporting goods (\$million)	40550	70603	90097	
Principal Statistics for All Manufacturing Establishments by Major Industry Group for 1999	1991	1994	1999	Total Counted Materials
Wearing apparel except footwear			25036	57131
Leather and leather products, except footwear and wearing apparel			212	
Footwear, except rubber, plastic and wooden footwear			32	
Textiles			26635	
Wood and cork products except furniture			389	
Furniture and fixtures, except primarily of metal			168	
Paper and paper products			3283	
Printing, publishing and allied industries			26175	
Chemicals and chemical products			7312	
Plastic products			3717	
Non-metallic mineral products, except products of petroleum and coal			8773	
Basic metal industries			6810	
Fabricated metal products, except machinery and equipment			6358	
Office, accounting and computing machinery			12600	
Radio, television and communication equipment and apparatus			2170	
Electronic parts and components			25490	
Electrical appliances and houseware and electronic toys			812	
Machinery, equipment, apparatus, parts and components, n.e.c.			12319	
Transport equipment			6341	
Professional and scientific, measuring and controlling equipment,			8737	

Consumption Analysis of Hong Kong and Guangzhou

n.e.c., and photographic & optical goods
Manufacturing industries, n.e.c.

8682

Consumption Analysis of Hong Kong and Guangzhou

Appendix L

Food Charts

Hong Kong's Import of Fruit Organized by Country

	Australia	Chile	Mainland China	Israel	New Zealand	Philippines	Thailand	United States	South Africa
oranges	2							1	3
grapefruits			2	3			1		
bananas						1	2		
apples			3		2			1	
grapes	3	2						1	

Key

1 = most fruit received from
 2 = second most fruit received
 from
 3 = third most fruit received
 from

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong's Import of Livestock and Meat Organized by Country

	Australia	Brazil	Mainland China	New Zealand	Thailand	United States
Lamb	2				1	3
Goat Meat				1		
Fresh Swine Meat					1	
Frozen Swine Meat		2		1		
Meat of Bovine	1					2

Key
 1 = most meat received by
 2 = second most meat received by
 3 = third most meat received by

Hong Kong's Import of Poultry Organized by Country

	Brazil	Mainland China	United States
Live Poultry			1
Fresh Poultry Cuts			1
Frozen Poultry Cuts	2		1

Key
 1 = most poultry received from
 2 = second most poultry received from

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong's Import of Vegetables Organized by Country

	Australia	Canada	Great Britain	Mainland China	New Zealand	Thailand	United States	Vietnam
Potatoes	2	3						1
Peas		1	2					
Beans					1	2		
Lentils					1			2
Tomatos	2				1			
Onions	3					2	1	
Lettuce	3				2		1	
Cucumbers					1			2
Fresh Prepared Vegetables					1		2 (much less)	

Key

1 = most vegetables received from

2 = second most vegetables received from

3 = third most vegetables received from

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong's Import of Crops Organized by Country								
	Australia	Canada	Mainland China	Malaysia	Myanmar	Japan	Thailand	United States
Wheat								1
Rice	2						1	
Barley	1							
Maize	1		3		2			
Oats and Grains	1							
Flour		3	1			2		
Cereal	1			2				

Key
 1 = Most crop received from
 2 = second most crop received from
 3 = third most crop received from

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong's Import of Dairy and Eggs Organized by Country

	Australia	France	Mainland China	New Zealand	United States
Milk	1			2	3
Cream		2			1
Butter	2				1
Cheese	2				1
Eggs				1	2 (much less)

Key

1 = most received from
 2 = second most received from
 3 = third most received
 from

Consumption Analysis of Hong Kong and Guangzhou

Hong Kong's Import of Fish Organized by Country

	Australia	Indonesia	Japan	Korea	Mainland China	Malaysia	New Zealand	Norway	Philippines	Taiwan	Thailand	United States
	2						1					
			3		1				1			2
			1		1							
		3	2			1						
				1								2
		2			1			1				
					1							
					1							
											3	

Key
 1 = most fish received from
 2 = second most fish
 received from
 3 = third most fish received
 from

Appendix M

