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Liquid Assets

Water Security and Management in the Pearl River Basin and Hong Kong

December 2009

Dinesh Sadhwani Jonas Chau Christine Loh Mike Kilburn Andrew Lawson

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Report layout and illustrations by Jonas Chau.

Foreword

South China, including Hong Kong and Macau, depends on the Pearl River and its tributaries. It is in our interest to protect, restore and sustain these rivers and the watershed as a whole for all times. The other major river systems in China – the Yellow and Yangtze rivers – suffer from severe pollution and over-use. The threats facing the Pearl River, although serious, are of a lower order of magnitude by comparison. It is thus incumbent upon the south to ensure that the key source of life is much better managed.

Civic Exchange is grateful to Noble Group for funding this research to focus attention on the Pearl River watershed. We want to increase public awareness about its centrality in the economic, social and political well-being of South China, and also its critical role to the continuing success of the Pearl River Delta, Hong Kong and Macau, which lies at the end of the river system. We hope this report will introduce the subject to a wide audience.

I want to take this opportunity to also stress the nexus between water and energy.

The world's energy system depends largely on fossil energy resources, which are mined, extracted and converted to energy and electricity. Enormous quantities of water are needed for oil extraction, oil refining, coal production, gas processing, electricity generation, and even in nuclear power production. These are all activities vital to South China too. They also cause severe environmental degradation and global climate change. Moreover, the burning of fossil fuel results in air pollution that leads to major public health problems. Climate change will bring about an increase in extreme weather conditions, such as more heavy rains, as well as more droughts, which will lead to changes in the water balance of many regions. South China is not immune to these changes in weather patterns. The message is clear – policy-makers need to look widely at water and energy management to make sustainable choices going forward. It will be challenging because we have always taken the availability of water for granted. We cannot do that anymore.

Christine Loh
Chief Executive Officer, Civic Exchange
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Mike Kilburn is Civic Exchange's Environmental Programme Manager. He has travelled widely in the Pearl River Basin, especially in the headwater regions of the Dongjiang, the North River and the West River, where he witnessed first-hand some of the problems covered in this report. Prior to joining Civic Exchange in June 2008, he was the Public Policy Analyst for Kadoorie Farm and Botanic Garden and has consulted with the Drainage Services Department, the Shenzhen Municipal Government and other departments to strike a balance between flood control, water quality management and protecting biodiversity in Hong Kong's waterways.

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GLOSSARY

Aqueduct: Constructed conduit to convey water over a long distance

Aquifer: Deposit or rock, such as a sandstone, containing water that can be used to supply wells

Basin: The catchment area of a particular river and its tributaries

Catchment Area: The area of land bounded by watersheds draining into a river, basin, or reservoir

Delta: The flat alluvial area at the mouth of some rivers where the main stream splits up into several distributaries

Estuary: The widening channel of a river where it nears the sea

Groundwater: Underground water that is held in the soil and pervious rocks

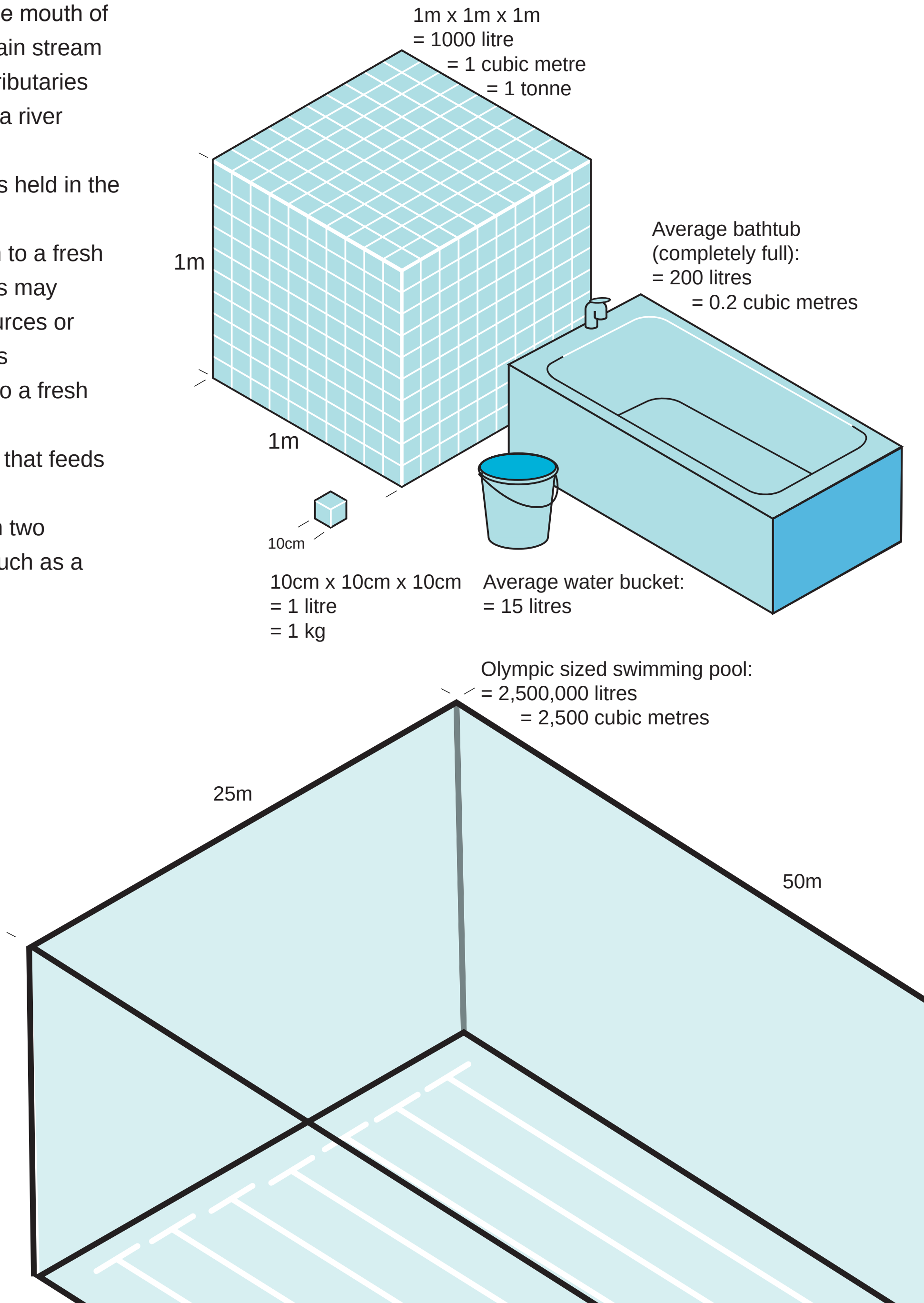
Saline Intrusion: Seepage of salty water in to a fresh water resource. The salts may originate from marine sources or terrestrial mineral sources

Sea-water Intrusion: Seepage of sea-water into a fresh water resource

Tributary: A stream, river, or glacier that feeds another larger one

Watershed: The dividing line between two adjacent river systems, such as a ridge

How much water?



Introduction

Hong Kong's fresh water supply is largely taken for granted. It is plentiful – just turn on the tap – and affordable, and by global standards considered safe enough to drink. As a result, water is rarely a subject of local public discussion. However, news of serious droughts in south China from time to time, including in 2009, is a reminder that Hong Kong's water supply is linked to the health of a larger hydrological system on the Mainland.

In China and in many other parts of the world, water-related issues are increasingly making headlines, and they rarely make cheerful reading. Issues range from serious contamination to flooding and droughts, and to the suffering experienced by people in water-stressed regions. Climate change will exacerbate these problems.

Much of Hong Kong's water supply comes from the Dongjiang (East River) a major tributary of the Pearl River, which runs from southern Jiangxi Province into northeast Guangdong Province and further south into the Pearl River Delta Economic Zone (PRD). Along the Dongjiang – and the Pearl River Basin as a whole – there is increasing competition for water supply as urbanization and industrialization expand in Guangdong. The rising demand for water is made more intense by loss of water quality from agricultural, municipal and industrial pollution, and the quantity available is impacted by short-term flooding and droughts, and in the longer-term by climate change.

Beyond providing water for drinking and washing, it is much less widely understood by the Hong Kong public that the same water catchment also supplies tens of thousands of Hong Kong-owned factories in the PRD for industrial use. Equally essential, the same water sources provide irrigation for agriculture and animal rearing for much of the food that is trucked to Hong Kong on a daily basis. Large amounts of water are also needed for power generation, without which economic activities would grind to a halt.

Beyond geography and hydrology, the administrative structure governing water policy-making and implementation is also exceptionally complex in Guangdong, Hong Kong, and Macau. Guangdong Province has hundreds of towns, townships, and sub-municipal districts, each of which have various functional responsibilities for the delivery of public services, including water-related ones. Hong Kong and Macau are Special Administrative Regions that have a high level of autonomy in decision-making but their governments are not part of the Mainland policy-making system, including in water issues. Going forward, administrative reform also needs to be considered if water resources are to be properly protected for the long-term.

This primer sets out where Hong Kong's water comes from, how it is used, and how this supply, both in Hong Kong itself and in the Pearl River Basin, might be affected by a range of possible impacts. Improving water management will be necessary to ensure the long-term health of the whole basin so that the socio-economic activities for several provinces and hundreds of millions of people in south China, including Hong Kong and Macau, can be assured and sustained in the long-term.

PART 1
Hong Kong's Fresh Water

DEMAND

In 2007, Hong Kong consumed about 950 million cubic metres of fresh water, and an additional 270 million cubic metres of sea-water for flushing purposes, or about 3.35 billion litres of water *every day*.[1] With a minimal agricultural sector and a diminishing industrial sector, domestic use now accounts for over 50 per cent of all fresh water use in Hong Kong.[2]

Hong Kong's domestic water (fresh and sea-water) use is about 220 litres per capita per day,[3] which is substantially higher than the global average of around 170 litres per capita per day.[4] The graph in Figure 1 shows the latest global data by the International Water Association; Hong Kong's household consumption level is notably higher than most of the major cities of the surveyed countries.

SUPPLY

Hong Kong's fresh water comes from three principal sources: from rainfall fed into its own reservoirs and water catchment network, from the Dongjiang in eastern Guangdong, and a small but significant proportion from bottled water.

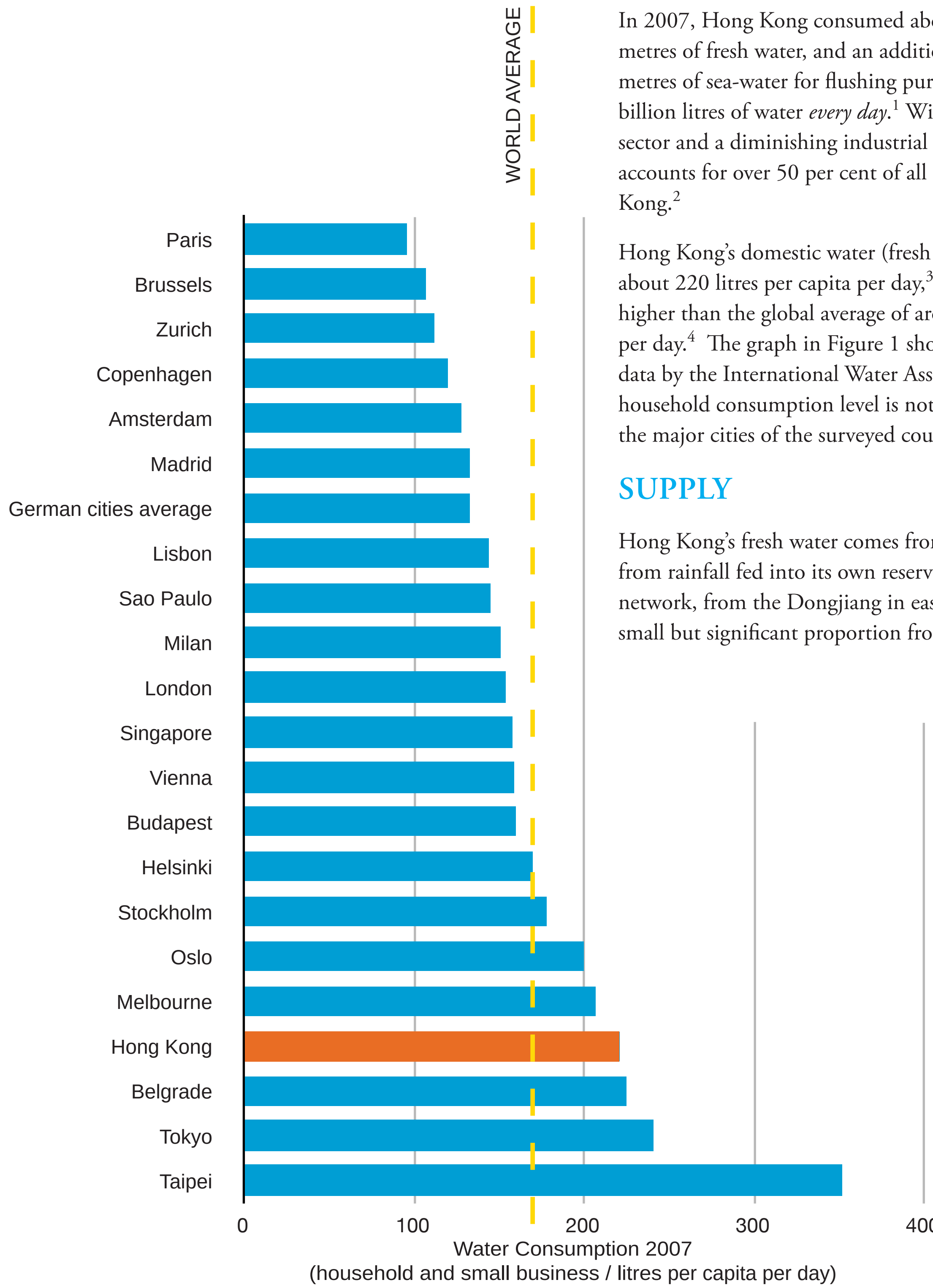
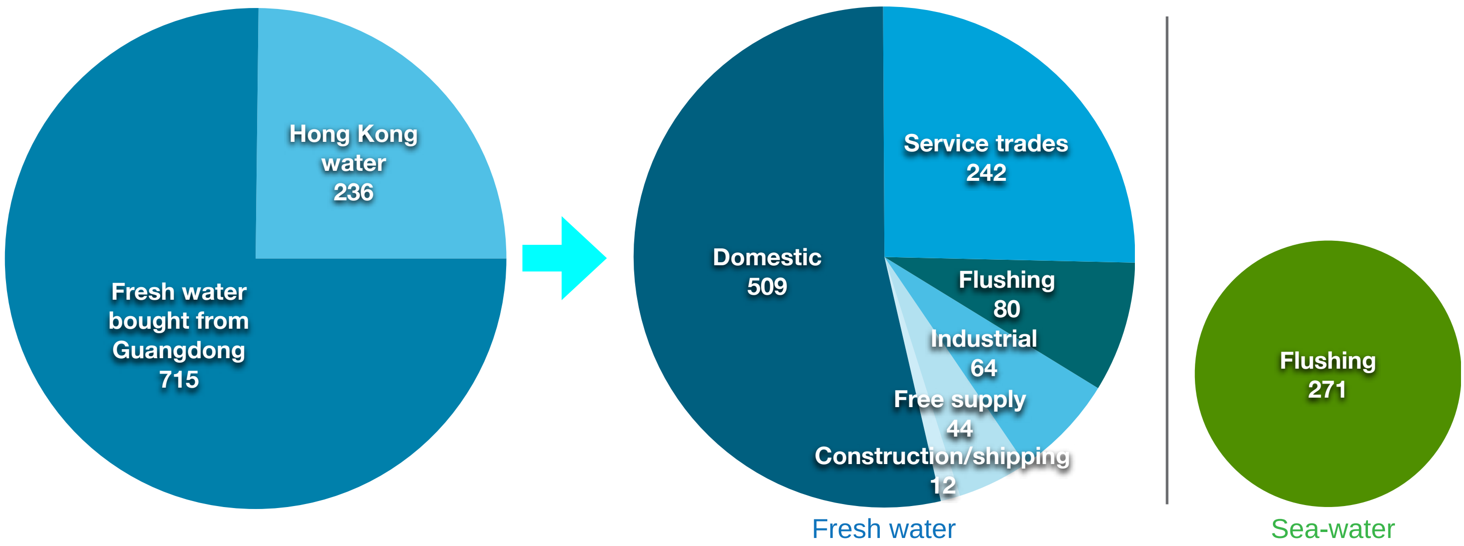


Figure 1: Water consumption among major cities

Data source: IWA (2008)[5]



Fresh water supply 2007
(million cubic metres)

Water consumption 2007
(million cubic metres)

Figure 2: Hong Kong water supply and demand

Data source: WSD (2008)[6]

Hong Kong's rainfall and reservoirs

When it comes to water supply, Hong Kong is fortunate that its location, directly affected by the south-west monsoon, ensures a regular supply of rain, which falls principally between April and September.

About one-third of Hong Kong's 1,098 square kilometres has been developed as water catchments.[7] Both Hong Kong's rain-water and water pumped from the Dongjiang is stored in 17 reservoirs throughout the territory (which have a combined capacity of 586 million cubic metres).[8] The vast majority of this network falls within the boundaries of Hong Kong's extensive network of country parks, which were established partially to protect Hong Kong's water-gathering grounds. As there is very little development within the catchments areas, locally collected water is largely free from contamination. However, the major drawback of this network is that the water collected falls far short of meeting the needs of the 7 million people now living in Hong Kong.

Looking beyond Hong Kong - a historical perspective

In the early 1960s, as Hong Kong's population climbed, the demand for water increased considerably, putting strain on the water supply system. Exceptionally low rainfall added an extra degree of urgency, and by 1963, even with water rationing in place, reservoir water levels fell to 1.7 per cent of their total storage capacity. The fisheries, agricultural, commercial and industrial sectors, as well as the general public were all severely affected by the drought.[9]

In 1963 and 1964, the Guangdong Provincial Government allowed water to be shipped from the Pearl River estuary to Hong Kong in tankers. Other commercial ships donated distilled water produced on-board or fresh water brought from overseas. The severity of the situation was a major concern.[10]

In 1965, the Hong Kong authorities and China reached an agreement that Guangdong would supply Hong Kong with water from the Dongjiang at a highly favourable rate, providing a long-term solution to the water shortage.[11] To this day, Hong Kong receives the great majority (70-80%) of its fresh water supply from the Dongjiang.[12]

Current fresh water supply agreement

Since 2003 Guangdong Investment Limited has managed the Dongshen water supply project, which sells raw water to Hong Kong, Dongguan, and Shenzhen, under a licence that will expire in 2030.[13]

Prior to 2005, Guangdong supplied water based on a unit price for a fixed quantity of water.[14] Under the current agreement, which runs from 2009 to 2011, Hong Kong pays a fixed annual sum, which allows supply to be based on actual rather than projected needs. Under this agreement Hong Kong receives an annual guaranteed maximum quantity of 1.1 billion cubic metres at an annual cost of HK$2.96 billion, HK$3.14 billion and HK$3.34 billion for 2009–2011 respectively.[15] These charges represent a cumulative increase of HK$1.96 billion above the previous agreement (2006-2008) which has been attributed to inflation and a stronger yuan.[16]

This arrangement has improved Hong Kong's ability to control the amount of water stored in reservoirs, reduce wastage, save pumping costs, and perhaps most significantly has allowed for a more efficient use of water from the Dongjiang across the PRD.[17] In 2007, Hong Kong consumed 715 million cubic metres of Dongjiang water, which represented about 65 per cent of the 1.1 billion cubic metres for which it paid.[18]

Dongjiang raw water - managing water quality in the river

The agreement signed between Hong Kong and Guangdong notes that water supplied to Hong Kong should be consistent in quality with the National Standard II as outlined in the *Environmental Quality Standards for Surface Water,*[19] which is published by the Ministry of Environmental Protection. The Guangdong authorities have implemented a variety of measures to ensure that the raw water delivered to Hong Kong meets these standards, including:[20]

- Building sewage treatment plants;
- Removing factories that may pollute the Dongjiang;
- Relocating the intake point to source water of better quality (it was moved upstream in 1998);
- Building a bio-nitrification plant at the Shenzhen Reservoir (commissioned in 1999);
- Constructing a dedicated aqueduct from the Dongjiang intake point to the Shenzhen Reservoir (implemented in 2003);
- Completing a project to intercept waste water flowing into the Shenzhen Reservoir (2004); and
- Diverting polluted water from the Shima River away from the Dongjiang (2005).

Water treatment and monitoring in Hong Kong

Beginning at the Muk Wu Pumping Station, where water from the Dongjiang enters Hong Kong, the Water Supplies Department (WSD) runs a comprehensive water quality monitoring programme that covers every stage of the water's journey from collection to treatment to distribution. Samples are collected from water treatment works, service reservoirs, connection points and trunk mains. These samples are tested through a series of chemical, physical, bacteriological, biological, limnological and radiological examinations, and assessed against the Guidelines for Drinking-water Quality recommended by the World Health Organization (WHO).[21]

The WSD maintains that the water quality within their system complies with WHO guidelines.[22] However, it does not guarantee quality at the tap, as water maybe affected by the conditions of a (private) building's plumbing, over which the WSD has limited or no control.[23]

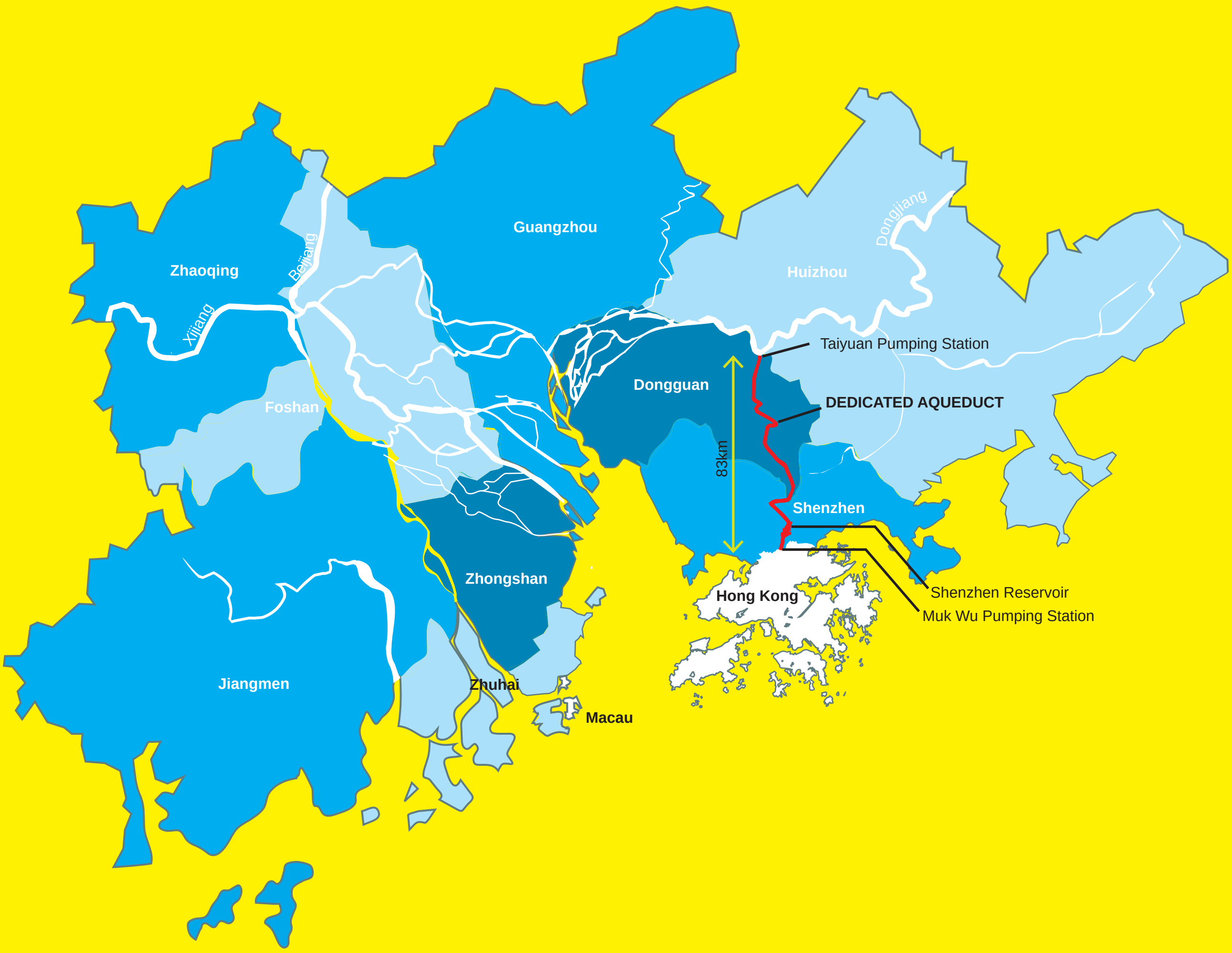


Figure 3: The Pearl River Delta Economic Zone

BOX 1: THE DEDICATED AQUEDUCT

Water is extracted from the Dongjiang, 83 kilometres north of Hong Kong, and is pumped over a succession of open channels and dams built across the Shima River, before it is eventually discharged into the Shenzhen Reservoir and transferred to Shenzhen and Hong Kong.[24] As the PRD's industrial and population development expanded rapidly in the early 1990s, the water quality of the Dongjiang River started to deteriorate. Factories along the Dongjiang were polluting the river, directly affecting the raw water supply to Hong Kong.[25]

In 1998, Hong Kong and Guangdong agreed to enhance the Dongshen water supply network. A closed aqueduct 59 kilometres long was built from the intake point on the Dongjiang (Taiyuan Pumping Station) to the Shenzhen Reservoir, isolating the water supply to Hong Kong from possible sources of pollution. The project was initiated in 2000, and was split into four stages involving the construction of water and underground conduits, pumping stations and other related structures. Guangdong was responsible for the design and construction of the aqueduct, which went into service in 2003, at a cost of about HK$5 billion.[26]

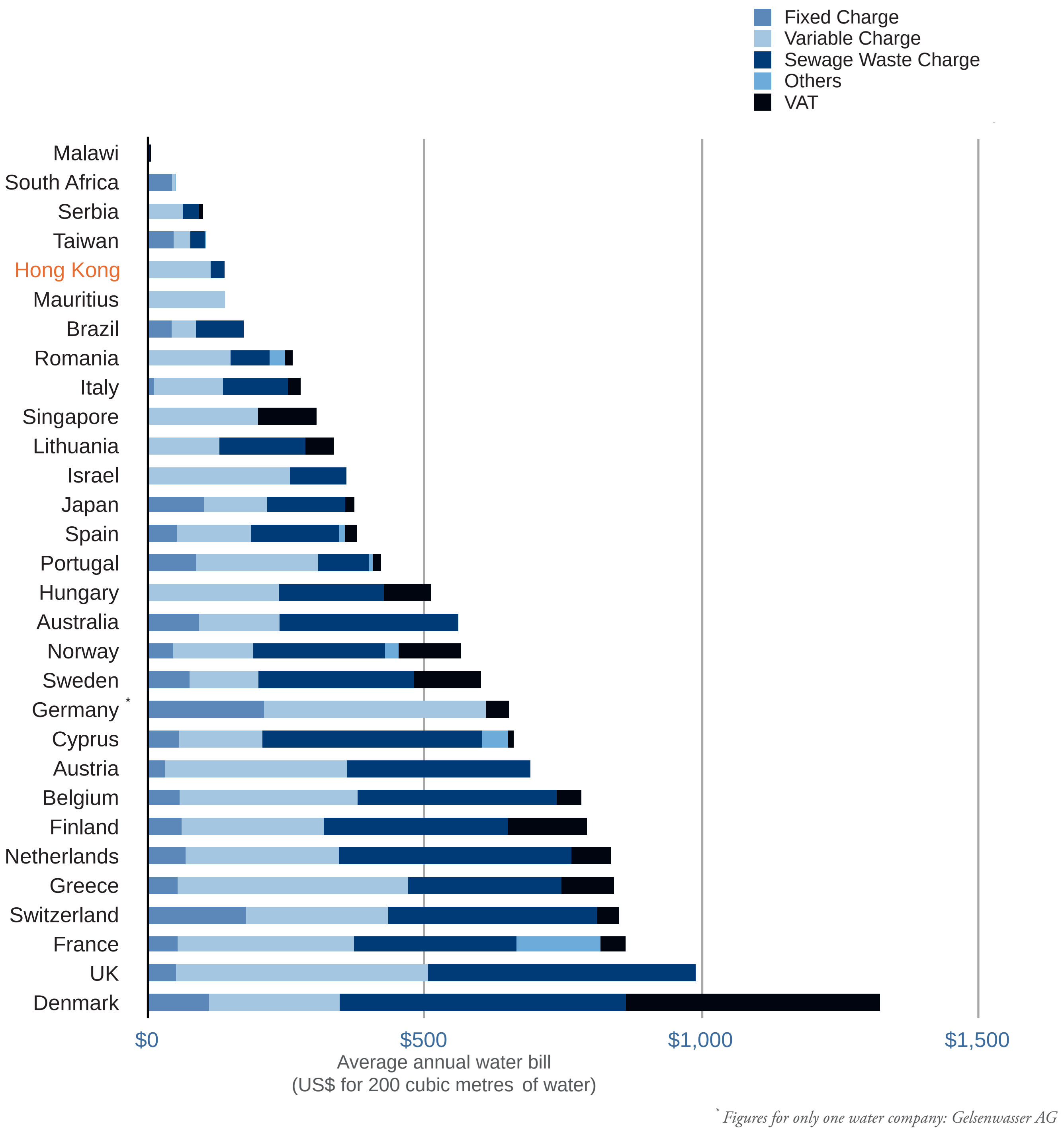


Figure 4: Average annual water bill among major countries and administrative regions (2007)

Data source: IWA (2008)[27]

DOMESTIC WATER CHARGES - AN INDICATOR OF WATER POLICY?

The most common way to manage the use of resources is through pricing. In general, low prices encourage consumption, and high prices discourage it. Since Hong Kong's water tariffs are amongst the lowest in the world, it is hardly surprising that its per capita consumption of water is among the highest (see Figure 1).

According to the current pricing regime, the first 12 cubic metres of water is free, followed by a tiered system ranging from HK$4.16 to HK$9.05 per cubic metre.[28] This equates to about a quarter of one per cent of average household expenditure. Yet for major cities in and around Asia the average monthly household water bill ranges from 0.5 to 0.9 per cent of average household expenditure, and in the United States and Europe average households in major cities pay between 0.5 and 1.5 per cent.[29] It is worth noting that the Chinese Government, which also prices water far below its true cost, recommends two to three per cent of average household income as a reasonable target.[30]

The WSD has noted that other cities do not provide a free allowance, and that subsidies to water charges are only provided to low income groups through financial assistance or rate rebates funded by the governments. Overseas experience also shows that subsidized water rates discourage water conservation, and indeed the WSD attributes the steady rise in per capita consumption of freshwater in Hong Kong in recent years squarely to the low tariff.[31]

To address this, the WSD had been open about the need for tariff reform. In their annual reports between 2000 and 2003 they proposed a range of measures including removal of the free allowance, cessation of subsidy from rates, recovery of full production costs, introduction of a two-part tariff composed of a fixed monthly service charge and a consumption charge, and the provision of direct subsidies only to low-income households.[32] This is in line with current policy pursued both in China and internationally.

However, with the Severe Acute Respiratory Syndrome (SARS) epidemic in 2003 and the ensuing economic downturn, the drive to raise tariffs has disappeared. The focus has switched to keeping water charges low and emphasizing that 'people in Hong Kong pay less for high quality freshwater than their counterparts in most other major cities around the world.'[33] Unlike other cities, Hong Kong has continued to provide a free allowance of water use and to subsidize its waterworks operations by as much as 15 per cent of annual rates received. The result is that the government now subsidizes more than 50 per cent of the community's water charges. According to the WSDs figures in 2003, 380,000 households (about 17 per cent of Hong Kong's total domestic accounts) paid nothing due to the free allowance. About 30 per cent of households paid a monthly water bill of HK$1 to HK$25, and only 21 per cent paid more than HK$75 per month.[34] As a result, nearly half of all Hong Kong households paid HK$25 or less per month for water. Even the most recent revisions of the water tariff have aimed to match the level of inflation rather than aiming to recover the full cost.

WIDER BENEFITS FROM THE PEARL RIVER BASIN

In addition to the guaranteed supply of potable water, Hong Kong derives substantial benefits from water resources in the Pearl River Basin. These include:

- ***Imported foodstuffs*** grown in the Pearl River Basin, which are dependent on the sustainable supply of sufficient water of adequate quality;
- ***Imported industrial supplies and commercial products*** manufactured in the Pearl River Basin by industries that require water in the production process (e.g. paper, ceramics, electronics and energy from power plants);
- ***Financial returns from investment in businesses and factories*** in the Pearl River Basin that require water. Insufficient water or poor quality water, as well as potential civil unrest related to water conflicts, may affect these investments and the returns they generate; and
- ***Marine-related benefits*** to the waters surrounding Hong Kong (marine biodiversity, marine recreation, fishing, and tourism) which are affected by the quality of fresh water outflows from the Pearl River and its tributaries. (For example, run-off of sediments and nutrients from Guangdong may cause 'red tide' algal blooms in the waters surrounding Hong Kong.)

Damage or disturbance to the water supply affecting these activities may have serious implications for public health, increased risks for business, reduced quality of life, a degraded environment, and even social unrest. Consequently, Hong Kong has a clear interest in supporting wise management of water resources across the Pearl River catchment. Before examining these threats and their possible implications for Hong Kong, this report will next look at the current state of the Dongjiang and the Pearl River Basin.

BOX 2:
SEA-WATER FOR FLUSHING IN HONG KONG

The use of sea-water for flushing in buildings is being increasingly encouraged in order to conserve Hong Kong's supplies of fresh water. [35]

Since the 1950s, the Water Supplies Department (WSD) has supplied Hong Kong with sea-water mainly for flushing purposes, first to the government and government-aided high-density development schemes, and subsequently to the urban areas of the city. Currently, the sea-water supply zone covers the urban areas on both sides of Victoria Harbour and a few new towns in the New Territories (potable water is used in all other areas for both toilet flushing and domestic consumption). Around 80 per cent of the population of Hong Kong currently uses sea-water for flushing.[36]

Sea-water is not subject to the same treatment as fresh water; it is screened in order to remove sizeable particles, and then disinfected with hypochlorite or chlorine before being piped to service reservoirs for distribution to the city. However, the high concentration of chlorine from the treatment process contributes to excessive corrosion of the pipe network. As a result, the frequency of burst pipes for the sea-water system is three times higher than that of the fresh water system.[37]

BOX 3:
BOTTLED WATER[38]

Hong Kong

In 2008, 275 million litres of bottled water were sold in Hong Kong generating HK$2.68 billion in revenues: 26 per cent of bottled water sales were on-trade (restaurants and bars) 74 per cent were off-trade (retail sales from stores). The demand for off-trade bottled water is expected to grow from 225 million litres in 2008 to 281 million litres in 2013. Total sales are expected to rise from about HK$2 billion to HK$2.5 billion over the same period.

Bottled water sales to institutions (i.e. bottles and water for dispensers to colleges, schools and offices) have also increased, reaching 827 million litres. Thus in 2008, off-trade, on-trade and institutional sales of bottled water totalled 1.1 billion litres. The HKSAR Government is an institutional buyer of bottled water, spending on average HK$16 million a year on this item.[39] Whilst water is supposedly regarded as a precious resource, Hong Kong people pay the same amount for 1,000 litres of tap water as they do for one litre of bottled water.[40]

Australia

In June 2009, residents of Bundanoon, Australia voted to ban bottled water in order to reduce its carbon footprint from bottling and transportation. In the following month, New South Wales Premier Nathan Rees ordered all state government departments and agencies to stop buying bottled water. Rees said the move would save taxpayers money and reduce the impact on the environment from the production and disposal of plastic bottles.[41]

Annual volume of bottled water sold in Hong Kong is roughly equal to the volume of Two International Finance Centre [42]

PART 2
The Dongjiang and the Pearl River Basin

Figure 5: Pearl River Basin in context with China

GEOGRAPHY

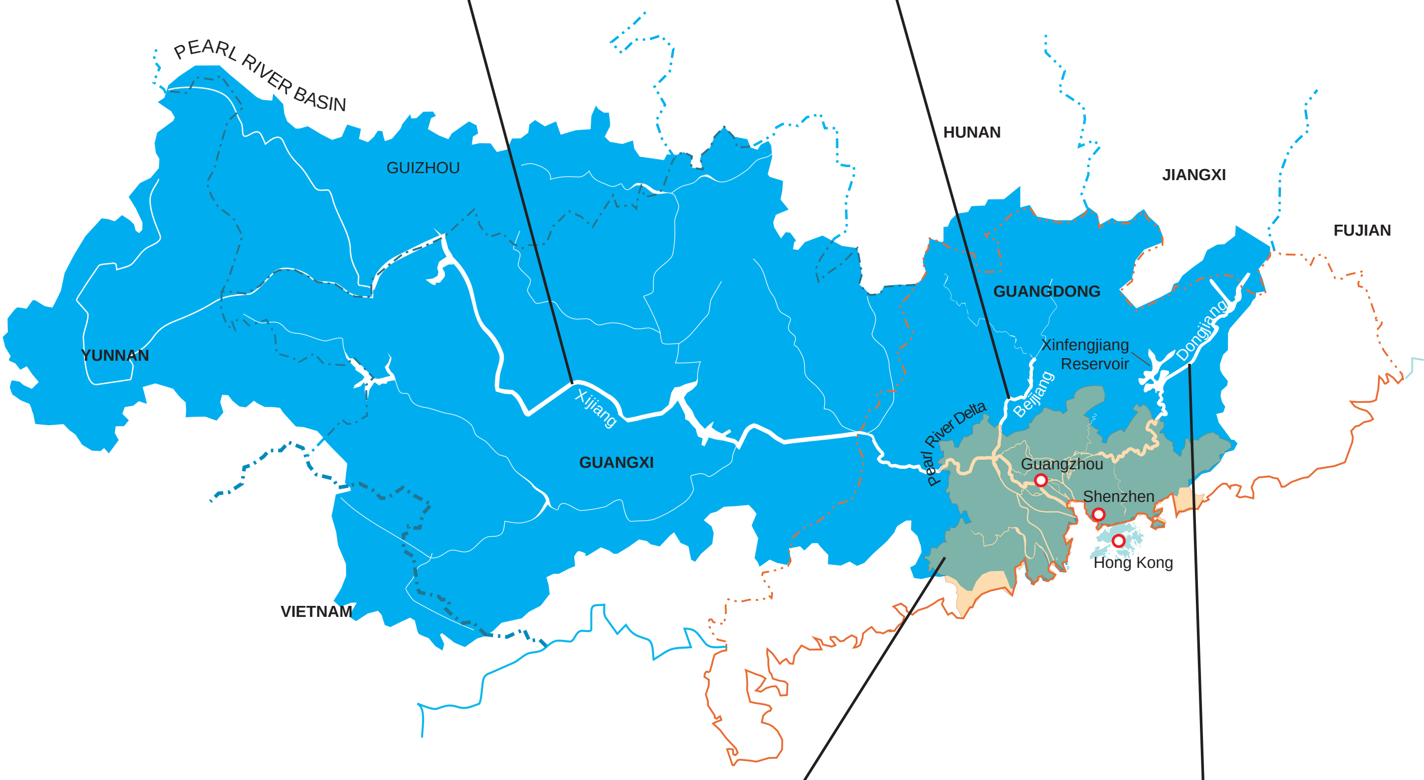
The Pearl River is the third longest river in China and ranks second in terms of volume of flow. It flows from Vietnam and Yunnan in the west to Guangdong in the south-east, where it drains into the South China Sea. It is made up of three major tributaries as well as the PRD waterway network. The average annual rainfall is 1,475 millimetres. Like Hong Kong, the Pearl River Basin is heavily influenced by the south-west monsoon, which characterizes a wet season that runs from April to September, and accounts for about 80 per cent of total annual rainfall.[43] The Pearl River Basin has total water resources of 284 billion cubic metres of surface water and 72 million cubic metres of groundwater.[44]

TRIBUTARIES:

The Pearl River is made up of three major tributaries: the Xijiang (West River) Beijiang (North River) and Dongjiang (East River).

The Xijiang rises in Zhanyi County, Yunnan Province. This tributary has a length of 2,274 kilometres, with a catchment area of 353,100 square kilometres.[45]

The Beijiang originates from Xinfeng in Jiangxi Province and is 468 kilometres long with a catchment area 46,710 square kilometres.[46]



These three main tributaries connect to the Pearl River Delta, a waterway network system comprising of water channels totalling 1,740 kilometres in length and an area of 10,000 square kilometres, forming a triangular delta and emptying into the South China Sea through eight main outlets.[48]

The Dongjiang is 523 kilometres long with a catchment area of 27,040 square kilometres and begins in Xunwu County, Jiangxi Province. It has 4.4 billion cubic metres of runoff and discharges 2.9 billion cubic metres of water into the Pearl River Delta annually.[47]

Figure 6: The Pearl River Basin

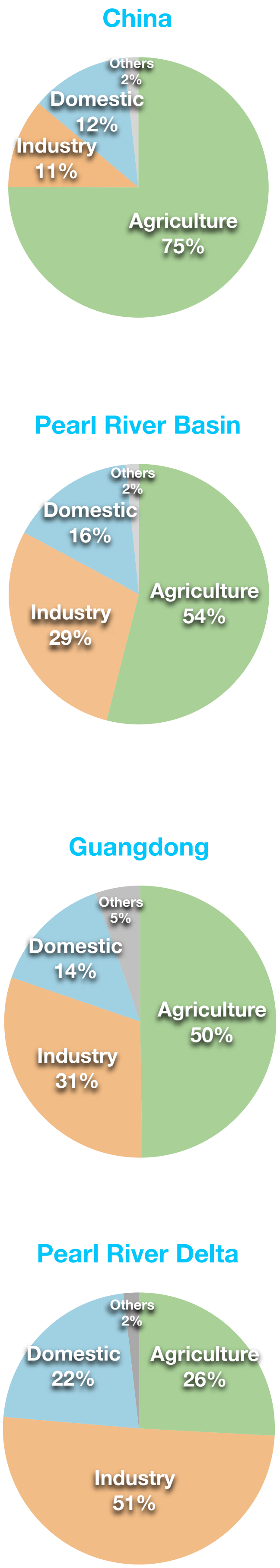


Figure 7: Water consumption across China (2007)

Data source: MWR (2008); PRWRC (2008)[53]

WATER USE

Figure 12 shows that the Pearl River is faring better than many of the other great river systems in China in terms of quality. Water resources for the basin total 284 billion cubic metres, allowing 2,383 cubic metres per capita. Water consumption in 2007 was about 63 billion cubic metres or about 526 cubic metres per capita. The PRD region is the largest consumer of water within the basin, using 20 billion cubic metres in 2007.[49]

Water is used mainly in agricultural irrigation, farming, and fisheries, which together account for 54 per cent of total water use. Following agriculture is industry, accounting for 29 per cent. Domestic use takes 16 per cent.[50]

SOCIAL AND ECONOMIC PROFILE

The Pearl River Basin provides water for most of Guangdong's 95 million people, plus about another 7 million in Hong Kong and half a million in Macau.[51] This population is heavily concentrated in the PRD, especially at its northern apex around Guangzhou, and along the eastern shore, where the cities of Dongguan, Shenzhen, and Hong Kong are located.

The rapid development of this region as a global centre of light manufacturing and high-tech industries is a well-known tale. But the heavy concentration of economic development in the PRD region has led to a widening wealth gap. In 2007, urban earnings per capita in Guangdong were five times higher than in Guizhou, which is upstream, while the earnings of an average urban resident in the PRD are over 30 times that of a rural worker upstream.[52]

ADMINISTRATION: GUANGDONG PROVINCE AND THE PEARL RIVER DELTA

Guangdong Province is divided into 21 administrative regions. The multi-year average water resource per person in the province is 1,927 cubic metres (some years are less than this; for example 2007 was 1,686 cubic metres per capita), which is less than a quarter of the global average.[54]

The PRD has high levels of fresh water resources compared to the rest of China. However, with rapid population and economic growth over the last 20 years, there has been an increasing number of incidences affecting quantity (resulting in water shortages) and quality (as a result of pollution).[55]

An important issue affecting the future development of the PRD is the natural environment. The rapid economic growth and expansion of the region has not been accompanied by the necessary infrastructure to prevent environmental impacts, and environmental degradation is severe in many parts of the region.

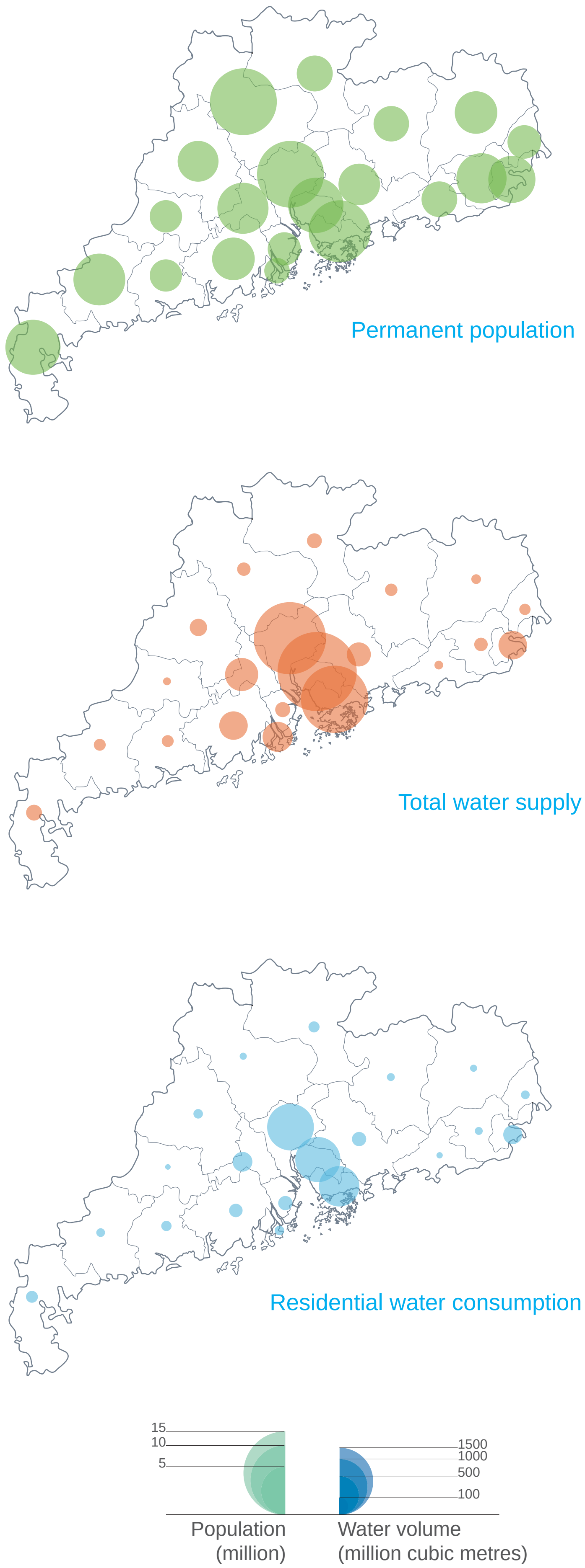


Figure 8: Comparison of population, water supply and consumption within Guangdong administrative regions

Data source: Statistics Bureau of Guangdong Province (2008)[56]

PART 3
Threats to water supply in the Pearl River Basin and beyond

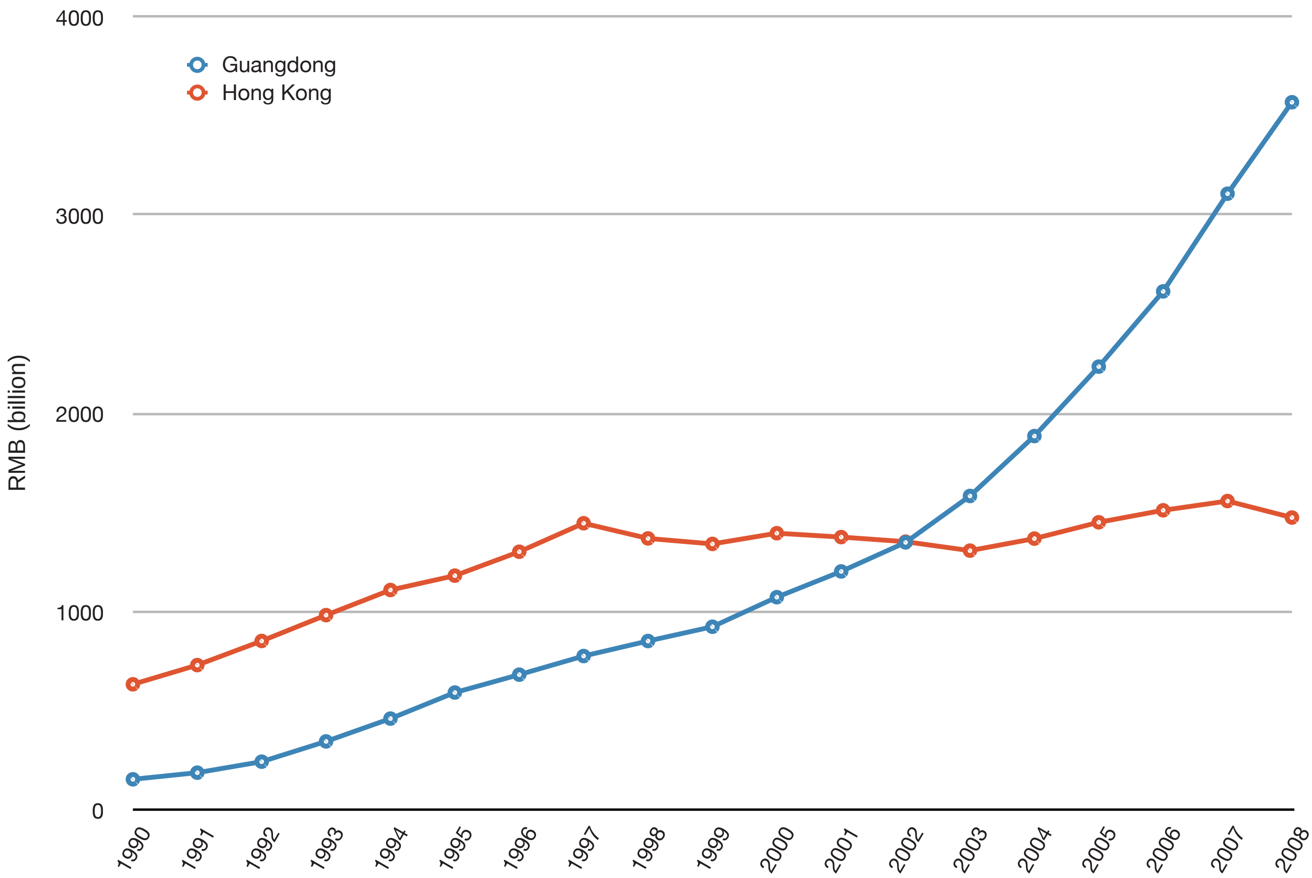


Figure 9: GDP of Guangdong and Hong Kong
Data source: Statistics Bureau of Guangdong Province (2009); CSD (2009)[57]

A literature review and interviews with water experts (i.e. academics, engineers, government officials, and NGOs) suggests that there are three broad areas of concern for Hong Kong (and indeed the whole of the south) in relation to its own indigenous water resources and the general water resources of the Pearl River Basin.

1
CLIMATE CHANGE

How will climate change affect the volume, distribution, and variability of rainfall in southern China? Preliminary research suggests that while total volume of annual rainfall is not at risk, the variability of rainfall will increase. Heavy rainfall events are likely to be more frequent, as will the occurrence of dry periods between major rainfall events. Research is needed to see how this might affect the demand for fresh water in the Pearl River Basin, and to identify the implications for the importation of fresh water and other water-dependent services to Hong Kong.

2
POLLUTION

Although less so than some of China's other great rivers (such as the Yangtze and Yellow Rivers) the Pearl River still suffers pollution from a variety of sources, and the delta's water in particular is heavily contaminated. Continuous data collection and publication is needed to identify principal sources of pollution in the Pearl River, and to track the success of measures to improve water quality.

3
COMPETITION AND MANAGEMENT OF SCARCE AND COMPROMISED RESOURCES

The intensity of competition for water is determined by the number and 'thirst' of users (people, farms, or businesses) seeking to use the available water after the portion rendered unusable by pollution has been subtracted. Data should be continuously collected, analysed, and published so that there is a regularly updated picture of who competes for water in the Dongjiang and the Pearl River Basin, how water is managed, and the effectiveness of the tools used for management (pricing, allocation, enforcement, and engineering).

PART 3.1
Climate change: an emerging threat to supply?

CLIMATE CHANGE AND CHINA

China is the world's largest emitter of carbon dioxide, having overtaken the United States in 2007.[58] While many countries face a huge challenge in dealing with environmental concerns that arise from climate change, China has a truly unique and awesome task with which to deal. There is the issue of the rapid retreat of glaciers in Tibet (the source of many rivers that feeds not only China but several other Asian countries). This in turn will affect water supply to a very large number of people including China's own people, as well as citizens of other nations. And there is the issue of natural climate disasters with which to contend.

Due to the size of the country, the influence of climate change will vary between seasons and regions. In the north of China, temperature increases will lead to even more water shortages, particularly in the arid areas where desertification is on the rise. However, episodes of heavy rainfall in the lower and middle reaches of the Yangtze River are increasing in frequency and will lead to more flooding. Too little rain in the arid zones and too much rain elsewhere are likely to lead to declining crop yields.[59] A recent report showed that the three largest river deltas in China – the Yellow, Yangtze and Pearl - are 'sinking' through a combination of sea-level rise and land subsidence from construction activities and over extraction of groundwater. The results are flooding and saline intrusions into fresh water supplies, leaving up to 100 million people at risk.[60]

CLIMATE CHANGE AND THE PEARL RIVER BASIN

Climate and rainfall

The Pearl River Basin, straddling the Tropic of Cancer, enjoys a mild and rainy climate with an average temperature in the 14 °C - 22 °C range. Rainfall distribution reduces gradually from east to west, with uneven rainfall distribution during the year in terms of volume, location, and annual variations.

Rainfall variation throughout the year is also uneven, with April to September accounting for over 80 per cent of total rainfall, and June to August accounting for over 50 per cent of the year's total volume. Geographical and seasonal variations are also high, and basin floods, drought, saline intrusion, and other natural events are not uncommon in the region.[61]

Drought

The PRD is particularly vulnerable to climate change; its low-lying nature makes it susceptible to sea-level rise and saline intrusion. Droughts and typhoons are also both common occurrences,[62] making flooding and drought prevention measures a high priority for governments in the region.

In 2004, the region experienced a severe drought. Over 2 million Guangdong residents were affected, as water levels in the major tributaries reached their lowest levels in 50 years. Economic losses from agriculture were estimated at RMB 1.4 billion and over 859 small and middle-sized reservoirs dried up.[63] Over one hundred hydroelectric plants in the south of China were ordered to close in order to preserve water for farming due to the drought.[64]

In 2009, Guangdong suffered another drought, which had affected over 50,000 people even before the beginning of the six month dry season. The average annual rainfall for 2009 was 1,400 millimetres, a decrease of 13 per cent from the annual average for that period in previous years.[65]

While individual drought years such as 2004 and 2009 are not, on their own, indicative of climate change, increasing fluctuations in rainfall are certainly consistent with climate modelling and predictions.

Reliability of supply from the Dongjiang

In the first 10 months of 2009, the Dongjiang basin received 24 per cent less rainfall than the average for that period

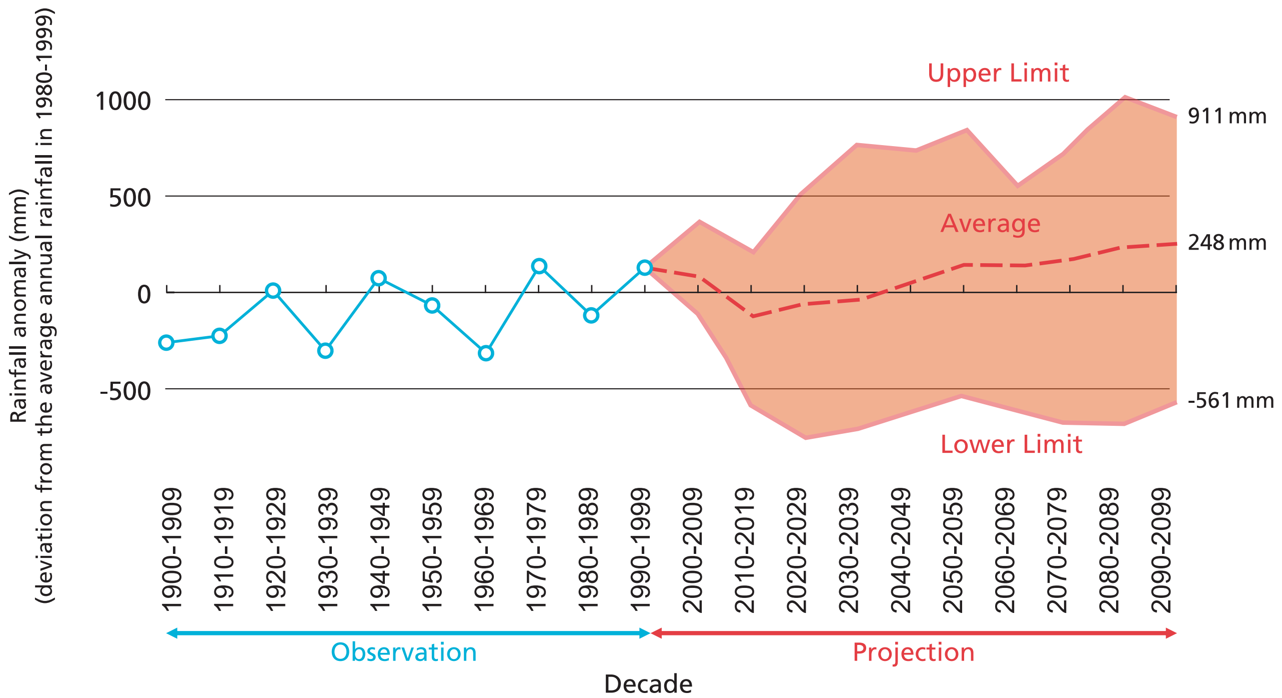


Figure 10: Hong Kong past and projected change in rainfall (relative to the average from 1980 to 1999)

Source: HKO (2009)[71]

in previous years. Huizhou, one of the major cities on the Dongjiang implemented drought management measures in preparation for the dry season starting in October.[66]

The HKSAR Government has stated that the drought will not affect Hong Kong's water supply, pointing to the agreement that guarantees Hong Kong's water supply even under drought conditions. This is certainly the case today but questions are being raised as to whether Hong Kong should become much more water efficient, and also develop other sources of water to reduce its dependence on the Dongjiang.[67]

CLIMATE CHANGE AND HONG KONG

Drought and reliability of water supply: Hong Kong's rainfall projections

Besides the Dongjiang, Hong Kong's second source of water is its own catchment system, which currently supplies about 20 per cent of the city's fresh water. Based on recent data from the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (2007) the Hong Kong Observatory (HKO) predicts that Hong Kong's annual rainfall will increase during the second half of the twenty-first century due to the influence of climate change. The HKO expects that in the final decade of this century Hong Kong's average rainfall will reach 2,572 millimetres, 11 per cent higher than in 1980-1999.[68]

Apart from the increase in average annual precipitation, year-to-year variability will also rise. Extremely wet years (defined as annual rainfall above 3,187 millimetres) are expected to increase from three between 1885 and 2008, to ten in the twenty-first century. Extremely dry years (defined as annual rainfall below 1,282 millimetres) are expected to double from two to four in the same timeframe. The twenty-first century will also see a rise in the number of days with heavy rainfall. From 2070-2099 the mean number of days in a year with hourly rainfall exceeding 30 millimetres will be 6.5, a significant increase over the average of 5.8 days between 1980 and 1999.[69]

The projections point to a consistent general trend of increasing variability for Hong Kong and the surrounding region: the wet season will become wetter, the dry season drier. Drier dry seasons will impact on Hong Kong's water security and wetter wet seasons will impact on the ability of water infrastructure to cope with increased volumes.[70]

PART 3.2
Pollution

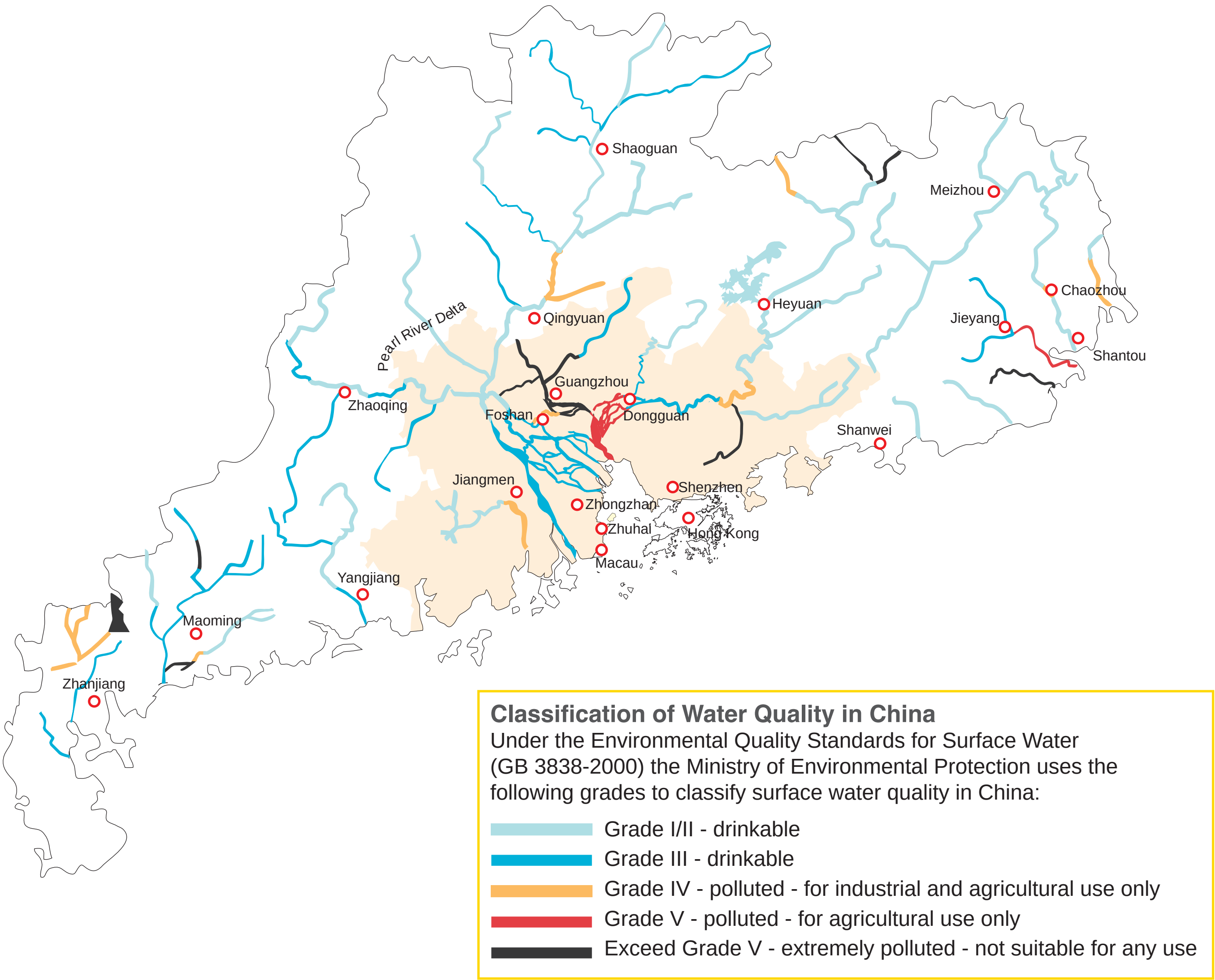


Figure 11: Guangdong's river water quality (2007)
Data source: Water Resources Department of Guangdong Province (2007); MEP (2002)[72]

GUANGDONG

It is widely recognized that water pollution is a serious problem afflicting several stretches of the Pearl River, especially the delta region. A water study from 2006 found that 42 of 111 rivers in Guangdong contained higher pollution levels than the previous year, and 28 of these rivers were severely polluted. This was because less than two per cent of wastewater in the province's townships and cities was treated. Only 22 of the townships and cities in Guangdong contained sewage treatment plants, but not all were in operation. Fifteen of the 21 bigger cities contained sewage treatment plants, but many were not attached to collections systems.[73] Even when waste and sewage is treated, local authorities must also deal with the treatment and safe disposal of contaminated sludge from water treatment works, especially those that serve industrial districts.

According to the Guangdong Water Resources Department, in 2007, 7.25 million rural people in Guangdong accessed polluted drinking water. Pollutants included arsenic (30,000 people), and fluorine (530,000), both of which may come from naturally occurring sources. 1.56 million people drank bitter or salty water.[74]

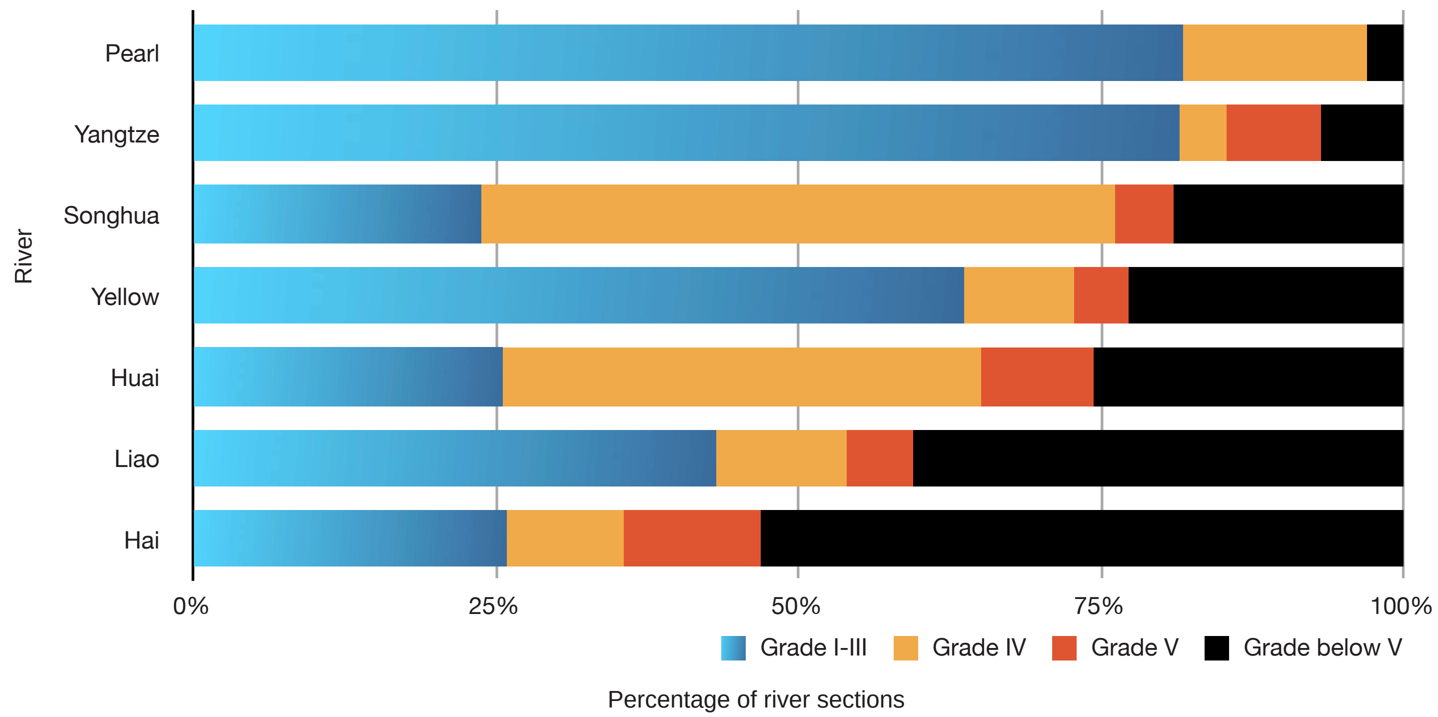


Figure 12: Comparison of river water quality in China (2007)

Data source: MEP (2007)[75]

POLLUTION IN THE PEARL RIVER

In 2008, among the 33 surface water sections of the Pearl River under the national monitoring programme, 85 per cent met Grade I-III, with just 12 per cent and three per cent respectively being of Grade IV-V and below.[76] However, on a more localized level the Pearl River's water quality, particularly around Guangzhou, Dongguan, Foshan and Shenzhen is very poor; much of it failing Grade V, making the river unsuitable for aquaculture, recreational and irrigation uses.[77] Petroleum, ammonia and nitrates were the principle pollutants.[78] This correlates closely with the findings of the National Marine Environmental Monitoring Centre, which reported that the Pearl River dumped 59,853 tonnes of petrol, 8,655 tonnes of heavy metals and 65,637 tonnes of nitrates and ammonia into the sea in 2005.[79]

On a broader scale, untreated wastewater is the primary source of pollution in Guangdong, with 12.5 billion tonnes of wastewater generated in 2007. Of this, 7.5 billion tonnes (60%) was from secondary industry (industry and construction) waste, urban residents produced 4 billion tonnes (31%), and tertiary industry produced 1 billion tonnes (8%). The heavily developed PRD accounted over 60 per cent of all the waste produced.[80]

Within the delta, Guangzhou is the heaviest contributor of wastewater (about 20%) followed by Shenzhen (11.3%) Dongguan (10.8%), and Foshan (7.3%). In 2006, Guangdong had a total of 6,486 industrial wastewater treatment plants. Although over 90 per cent of factories claim to adhere to wastewater discharge standards, water quality remains an issue of concern.[81]

In July 2009, the *Nanfang Daily* published a series of special reports focusing on pollution issues affecting the Pearl River. A Guangdong official stated that environmental protection is a game of cat-and-mouse with offenders. There are only 4,000 inspectors in the whole province, and offenders often operate irregularly and during the night when monitoring is more difficult.[82]

A part of the Pearl River that flows through Guangzhou was polluted by black water from an upper river branch in 2008. Similar pollution incidents have been happening over the past two years, and there are no persuasive explanations as to how the pollutants are released and what they are despite continuous complaints. One investigation carried out by the local environmental protection bureau said the pollution was caused by dirty black silt that had been dredged from the riverbed when a power plant's waste was discharged. However, the extended period of pollution made this explanation seem unlikely.[83]

THE XIJIANG (WEST RIVER)[85]

The Xijiang holds 78 per cent of Guangdong's water throughput. Each year it is subject to 3 billion tonnes of sewage, transport pollution, illegal sand trawling, falling water levels and saline intrusion. The increase of industrial activities upstream is also a source of pollution.

Guangzhou's extraction of water from the Xijiang has led to sea-water intrusion that could contaminate fresh water supplies in Zhuhai and Macau. As Guangzhou and Foshan respectively divert 3.5 million cubic metres and 2.4 million cubic metres per day, Zhuhai and Macau suffer the consequences of this diversion, especially in drought years and during the winter dry season.

THE BEIJIANG (NORTH RIVER)[86]

The Beijiang has suffered from pollution from three main sources for many years:

- **Copper, lead, and zinc mining in the Fankou area**
  Dabaoshan has been an important mining district for copper and other heavy metals due it its copper-rich iron ore. Recently a molybdenum deposit worth RMB 70 billion was discovered, securing mining as an important industry for the area. Mining produces heavy metals and highly acidic (up to pH2) wastewater. However, efforts to upgrade Dabaoshan's mining processes are underway.

- **Smelters in Shaoguan**
  Smelters in Shaoguan produce vast quantities of air and water pollution. In 2005, a smelting plant polluted the Beijiang with ten times the safe level of cadmium.[87]

- **E-waste disposal industry around Shi Jiao**
  Copper and other heavy metals are extracted from insulated wires and machines. This produces sulphuric acid and metals such as thallium as waste. A survey conducted by the Pearl River Fisheries Research Institute of Science and Technology showed that 60 per cent of water products downstream from Shi Jiao contain extremely high levels of lead.[88]

Recent serious pollution incidents have prompted action from the authorities. Industrial parks have been set up away from the Beijiang to house eight electroplating factories identified as serious polluters. Fines of up to RMB 2.5 million have been levied, and offenders have been ordered to establish their own water recycling plants in industrial parks at a cost of tens of millions of yuan. Huaqing Industrial Park was established near Shi Jiao to improve the environmental performance of small industries.[89]

THE DONGJIANG (EAST RIVER)[90]

Mining, quarrying and large-scale fruit plantations around the headwaters of the Dongjiang have caused water quality deterioration and soil erosion. These activities take place on both sides of the Jiangxi–Guangdong border, which adds further complications for environmental monitoring and enforcement.

In 2005, Jiangxi Province committed RMB 1.42 billion to protect the Dongjiang headwaters region, part of which was allocated to increasing forest cover by up to 85 per cent. Since then, Guangdong and Jiangxi have developed the Dongjiang Ecological Compensation Programme. Under this programme, between 2005 and 2025, Guangdong will allocate RMB 150 million to compensate Xunwu and Anyuan, two poorer counties in Jiangxi, for lost development opportunities from closing down industries and enterprises.

Despite these measures, activities including mining, abandoned quarries, chemicals, and waste emissions are still affecting this region. In 2008, the Jiangxi Provincial Water Resources Department reported rare-earth mining waste discharges had produced high levels of nitrogen, phosphorus, potassium permanganate, and arsenic in the Nanshui River. Much of this pollution is diluted and absorbed by the time it reaches Guangdong, but it is not totally eliminated. In September 2008, Guangdong's Environmental Protection Department allocated an additional RMB 27 million for a Water Pollution Research and Control System in the region.

The Pearl River's tributaries: problems and solutions[84]

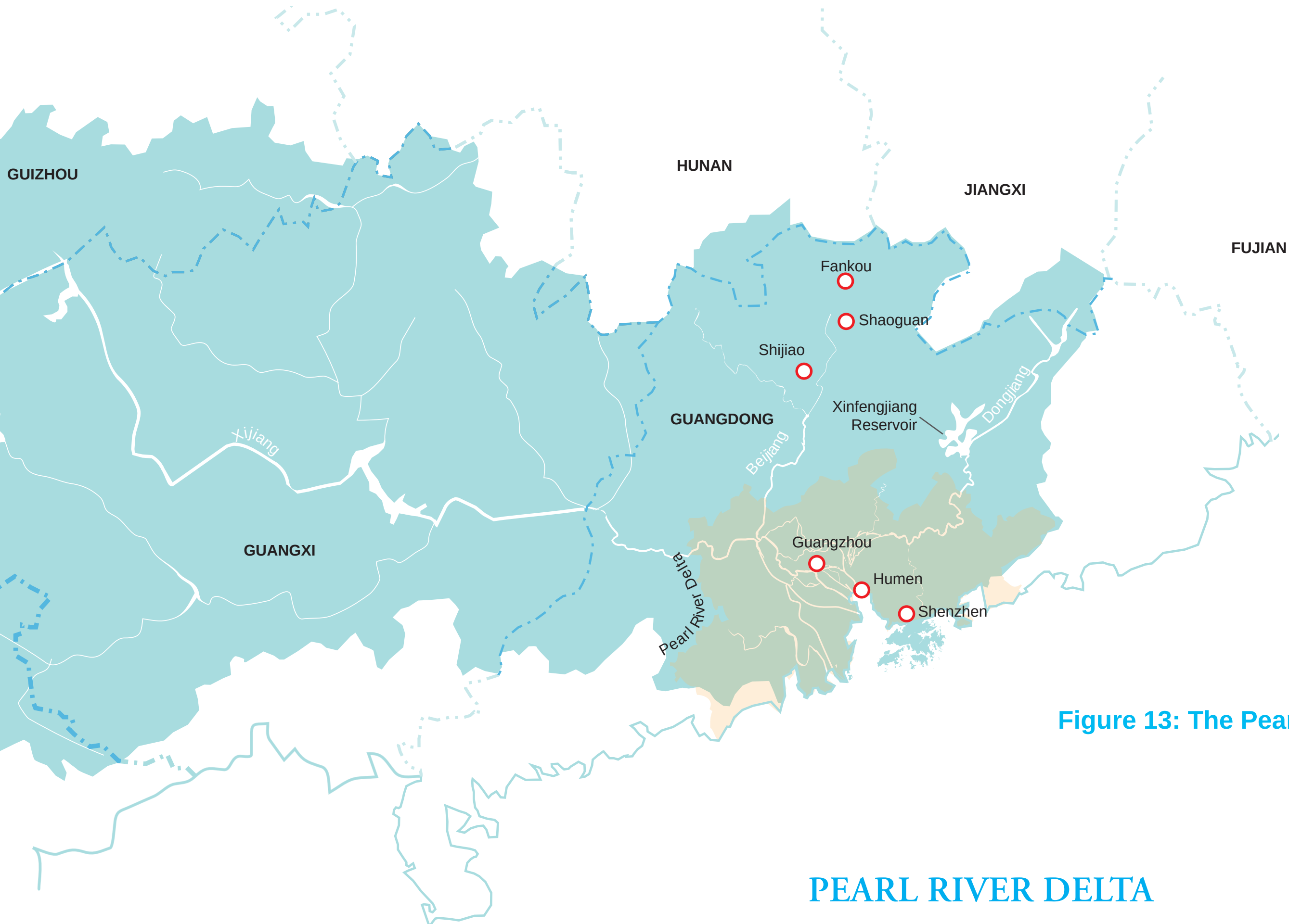


Figure 13: The Pearl River Delta

THE PEARL RIVER ESTUARY[91]

As manufacturing has expanded around Humen on the west bank of the Pearl River Estuary, this stretch of coastline has become the most polluted of the inshore waters in Guangdong. The traditional fishing industry has suffered and is struggling to survive. The district plays host to electrolysis plants, dyeing factories, and other heavily polluting industries. The area is also distinctive for its lack of a corresponding number of waste treatment facilities.

In 2008, a Guangdong marine environment gazette showed that the seas around Guangdong are the second most polluted coastal area in China behind the Bay of Bohai. Further upstream, the Guangzhou section of the Pearl River fails to reach Grade III for 98 per cent of the year. The reason for this is that the blunt approach to dealing with heavily polluting industries has driven the offending enterprises upriver, from where their discharges continue to affect the water intake for Guangzhou.

PEARL RIVER DELTA

The PRD has developed swiftly but at severe cost to the environment. In particular, water quality along many stretches of the Pearl River is so polluted that it exceeds Grade V water quality classification.[92] The PRD region discharges almost 55 per cent of the Pearl River's sewage even though it constitutes less than seven per cent of the entire system.[93] In 2001, Shenzhen treated only half of its sewage output into the Pearl River, and Guangzhou only 23 per cent.[94]

Local governments have also allocated funds to confront the problems. Dongguan's expenditure on sewage treatment projects will total RMB 4.78 billion by 2010. Guangzhou has instructed many polluting plants to shut down and has introduced strict regulations for other organizations that discharge waste.[95]

From the 1980s to the early 1990s, the bulk of Hong Kong manufacturers relocated to Guangdong, taking advantage of the lower running costs and available land, where environmental enforcement was not as strict.[96] Since then the law has tightened, and a textile firm in Dongguan, owned by a Hong Kong listed company, was fined RMB 11.55 million for discharging over ten million tonnes of wastewater through an underground pipe between 2004 and 2006. This is believed to be the heaviest fine ever imposed for illegal sewage release in Guangdong.[97]

ADDRESSING THE PROBLEM

In 2002, the Guangdong Provincial Government announced it would spend RMB 36.2 billion over a period of eight years to clean up the Pearl River, building over 160 wastewater treatment plants and increasing urban sewage treatment rates to 60 per cent. Two years later, the province announced the implementation of over 100 projects dealing with water treatment and supply, protection of the rural environment, prevention of pollution, and waste treatment.[98] More recently, the Guangdong authorities have committed to invest more in environmental facilities and plan to increase the share of environmental protection investment from 2.5 per cent of GDP to three per cent by 2010.[99]

Looking forward, the National Development & Reform Commission's consultation paper '*The Outline of the Plan for the Reform and Development of the Pearl River Delta (2008-2020)*' envisages that by 2012 and 2020, urban wastewater treatment rate will reach 80 per cent and over 90 per cent, respectively, and the industrial wastewater discharge compliance rate will also reach 90 per cent in 2012, and 100 per cent in 2020.[100]

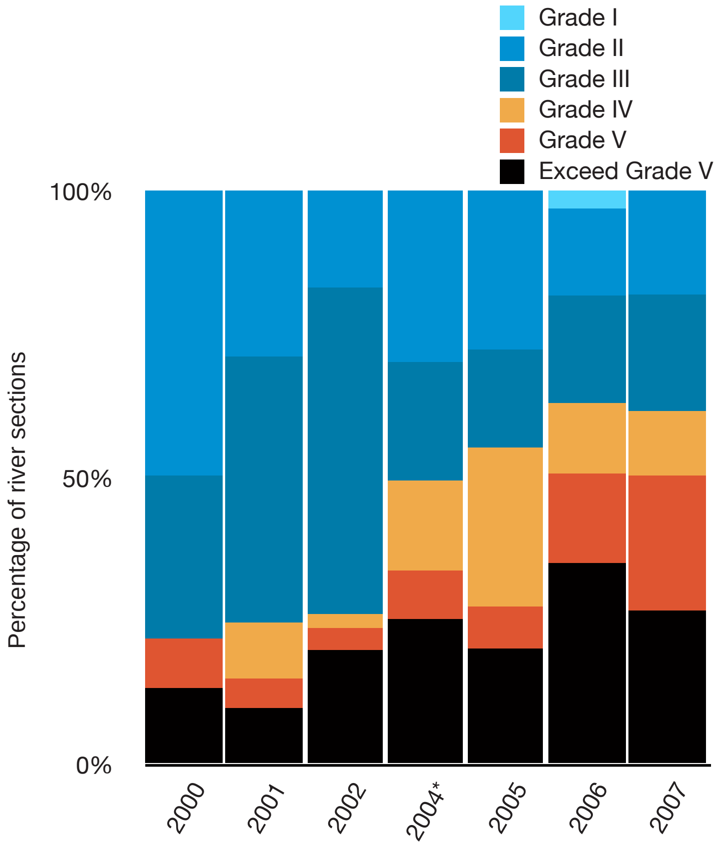


Figure 14: Pearl River water quality within the PRD

Data source: PRWRC (2000-2007)[101]

** 2003 data unavailable*

Pearl River Delta
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PART 3.3
Competition

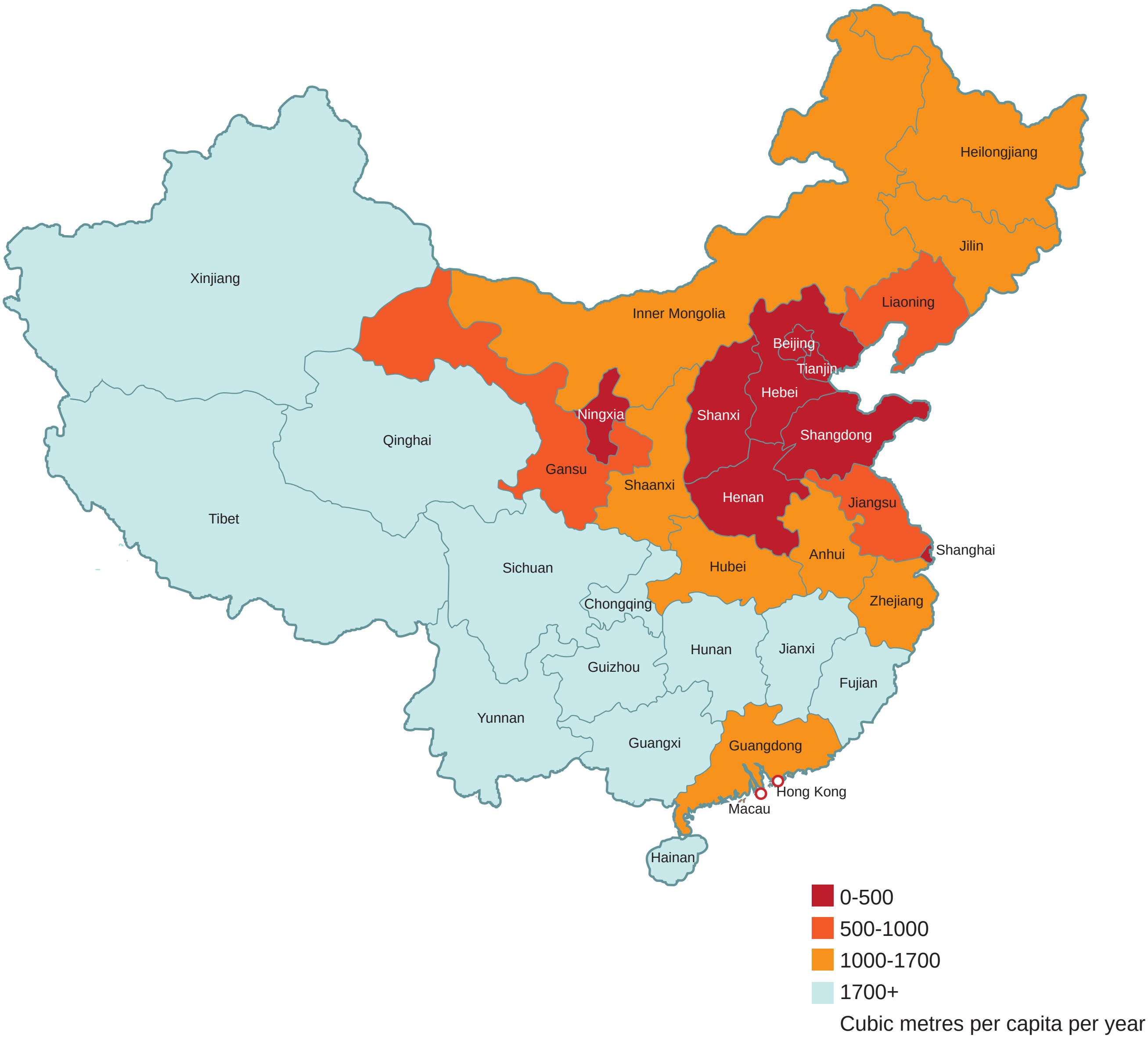

Figure 15: Water resources per capita in China by province(2007)
Data source: National Bureau of Statistics (2008)[102]

Using 2007 figures (the latest figures released by the PRD Government), Guangdong was water-stressed according to standards set by the United Nations Environment Programme.[103] Yet the industrial development and urbanization of the Pearl River Basin and especially the PRD continues headlong – and water allocation is already a fact of life for cities drawing their water from the Dongjiang. This section examines the institutional framework and some of the tools employed for managing water. The region's issues are also placed in the context of competition for water across the rest of China.

CHINA'S WATER PROFILE

China, with seven per cent of the world's water supply, is ranked fourth in the world in terms of available water resources.[104] Despite this, in 2007, with a population of 1.31 billion, China's water resources per capita were relatively low in the world, at 1,869 cubic metres, when compared with the Asian average of 3,948 cubic metres and the global average of 8,210 cubic metres.[105]

The water resources of the north and south of China are considerably different. The south, with 2,822 cubic metres per capita and over 80 per cent of the country's water resources, is water rich. However, the north, with just 828 cubic metres per capita, is arid, despite being a significant agricultural area, responsible for much of China's industrial production, and having a population roughly equal to the south. As a result, 538 million people (42%) have access to a mere 14 per cent of China's water, which has led to heavy exploitation of water resources.[106]

The disparity between the two regions led Beijing to create the South-to-North Water Diversion Project.[107] The Central Government is willing to spend heavily to construct massive and controversial engineering works to compensate for the water stress of one basin with the water resources of another. The Central Government has also diverted water to important cities, as it did to ensure that Beijing had enough water ahead of the 2008 Beijing Olympic Games.[108]

The United Nations Environment Programme (UNEP) defines water scarcity as a state in which 'the amount of water withdrawn from lakes, rivers, or groundwater is so great that water supplies are no longer adequate to satisfy all human or ecosystem requirements, bringing about increased competition among potential demands.' Quantitatively, 'water stress' is regarded as the situation where water resources are between 1,000 and 1,700 cubic metres per capita. Less than 1,000 cubic metres per capita is regarded as water scarcity.[109]

Both contemporary and historical trends can explain China's water scarcity in the north and east. People have settled in these parts of the country despite low water resources, leaving China with a high population density in these regions. Recent economic and population growth have further increased the demand for water, whilst technical defects in the water supply facilities (e.g. leaking irrigation systems account for 20% of China's total water usage) and pollution of water basins have decreased availability of water resources.[110]

BOX 4: GROUNDWATER

Groundwater plays a key role in China, as it provides potable water for about 70 per cent of the population and irrigation for 40 per cent of the country's agricultural land.[111,112] However, nine out of ten cities in China face severe groundwater contamination,[113] and the rate of groundwater extraction is so great that parts of northern China have seen the water table drop at a rate of more than one metre per year.[114]

(billion cubic metres)	Surface Water Resources	Surface Water Supply	Groundwater Resources	Groundwater Supply
China	2,424	472	762	107
Guangdong	157	44	41	2

Table: Surface and groundwater resources and supply for China and Guangdong (2007)

Data source: National Bureau of Statistics of China (2008)[115]

BOX 5:
SOUTH-TO-NORTH WATER DIVERSION PROJECT[116]

Figure 16: South-to-North water diversion project
Source: adapted from BBC (2009)[117]

Proposed in 1952 by former Chairman Mao Zedong to ease the water shortages in the north of China, construction of the project was started in 2002, and is expected to end in 2050. The project involves three phases with routes in the west, east and centre of China, which will ultimately transfer about 45 billion cubic metres of water per year from the Yellow, Huai, Hai and Yangtze Rivers. The eastern, central, and western routes are all expected to be around 1,200 kilometres each, and will divert about 15, 13, and 17 billion cubic metres, respectively per year. Overall the project is estimated to cost more than US$423 billion, twice the cost of the Three Gorges Dam.

China recently announced that the water diversion project would be delayed, due to unexpected environmental damage and the resettlement of people.[118] The delay will affect the central section for a further four years, with the completion date shifting to 2014 instead of the planned 2010.[119] Because this section affects Beijing's increasing demand for water, a 309 kilometre canal from Hebei to the capital city was rushed into service to supply it with water.[120] Both environmentalists and scientists have opposed the project, claiming that it will only offer a temporary solution to the water crisis and at the same time damage the environment and waste billions of dollars.[121]

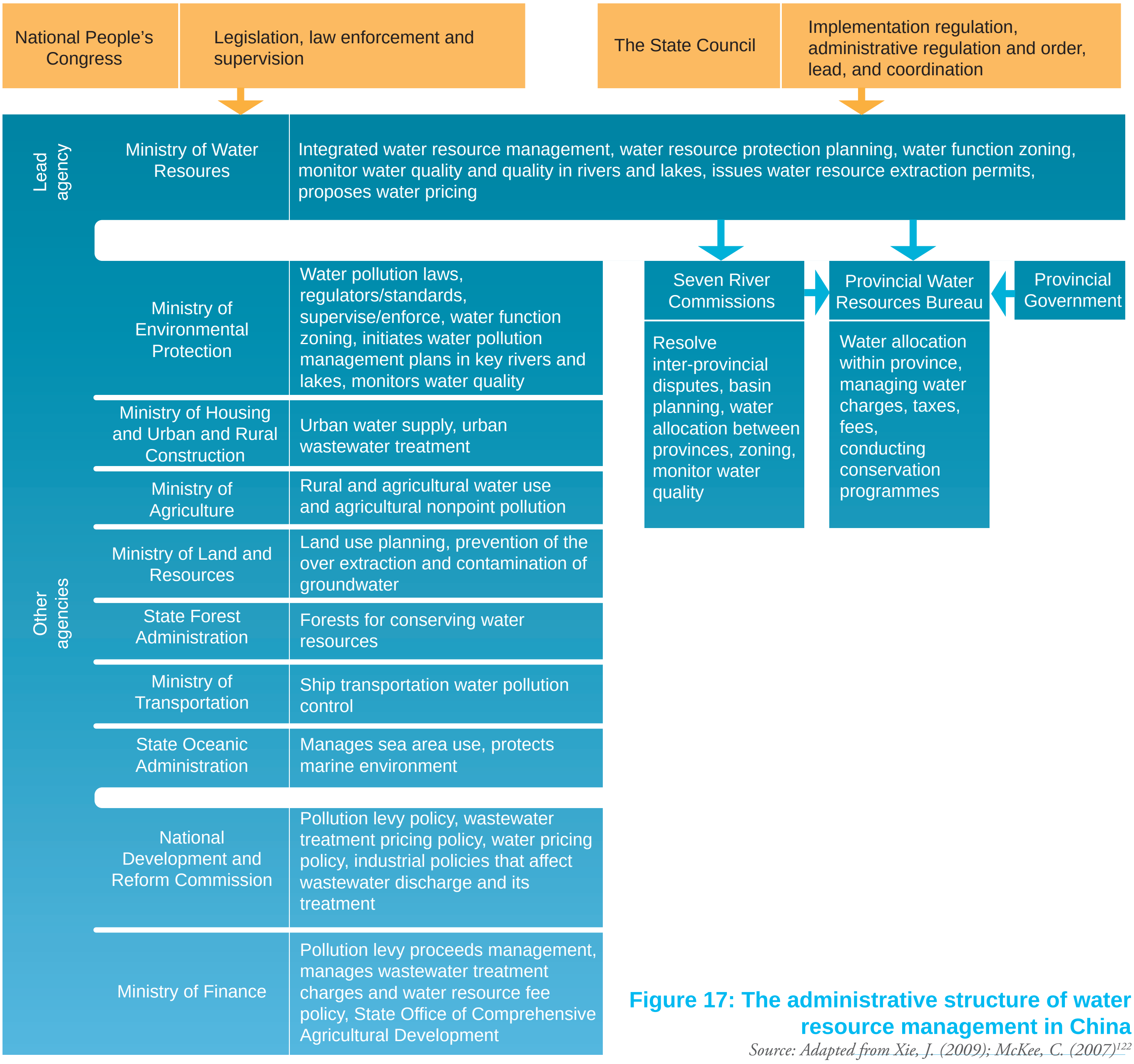

Figure 17: The administrative structure of water resource management in China

Source: Adapted from Xie, J. (2009); McKee, C. (2007)[122]

MANAGEMENT OF WATER

The principal authority responsible for managing water in China is the Ministry of Water Resources (MWR).[123] However, many government bodies have some degree of responsibility in the planning, managing, monitoring, and enforcement of water-related issues. Unravelling the various interlocking and overlapping strands is beyond the scope of this paper, but the chart in Figure 17 offers an indication of the degree of complexity involved.

The supervision of water pollution control and prevention is also separated. The Ministry of Agriculture is responsible for diffuse agricultural pollution control, whilst the Ministry of Environmental Protection (MEP) is in charge of municipal and industrial pollution control and prevention, and the Ministry of Transportation for ship transportation water contamination control. As a result, for a water body that is polluted by several sources, the management of water quality would involve these establishments and the MWR, as water quality and quantity are linked (more water creates more ability to dilute pollutants). This increases the management of water quality, both in administrative costs and complexity.[124]

The boundaries between the institutional jurisdictions are not always defined and have created conflicts in responsibilities within the system. Thus, it has affected the efficiency of water management, and raised the administrative cost for coordination among the different ministries and institutions.[125] The management of water quality and quantity are separate from one another under the MEP and the MWR respectively; this has resulted in two independent sets of planning procedures for water quantity and quality management across basins, with the actual execution being the responsibility of local authorities. In addition, both the MEP and the MWR monitor the major rivers and their water quality; however they have their own water monitoring stations and don't share their databases with each other. This system is also reproduced at the local level in provinces, counties, and prefectures.[126]

THE PEARL RIVER WATER RESOURCES COMMISSION

The establishment of the Pearl River Water Resources Commission in 1979, under the MWR, was the earliest effort to create a comprehensive management regime for the Pearl River Basin. Its principal functions are:

- Enacting the *Water Act* and other laws and regulations, including enforcement, monitoring, investigation of illegal operations, and inter-provincial water disputes and mediation work;
- Integrated river basin planning, river basin projects, management of nationally-backed cross-provincial infrastructure projects including hydropower projects;
- Management of river basin water resources (including surface water and groundwater) and the development of water allocation programmes between provinces within the basin;
- Water resources protection, including zoning and monitoring of wastewater discharges especially in protection areas and recommending discharge limits;
- Flood prevention programs and drought control scheduling; and
- Basin conservation programmes.[127]

However, considerable authority also lies with local level Water Resource Bureaus, which establish policy, set prices, and may take other political or economic factors into account in decision-making.[128] Each has its own priorities, making trans-boundary river management a complicated matter. With an understandable focus on making use of local resources to meet local needs, local authorities generally give a low priority to basin-wide and sectoral objectives.[129]

For example, the greater part of the funding for water savings and pollution reduction must come from local budgets with only a small amount allocated by the Central Government, while the benefits are generally felt downstream. As a result the current system of water management is effectively based on the administrative boundaries of the different government levels rather than the River Basin Management Commissions (RBMCs). To make matters worse, RMBCs do not include representatives from the affected municipalities and provinces, making effective collaboration with key stakeholders extremely difficult.[130]

At the provincial level, authority rests with the Water Resources Department of Guangdong Province. It has a key role in water allocation within the province, managing water charges, taxes and fees, and conducting water conservation programmes.[131]

WATER PRICING: CONTROLLING DEMAND AND RESTRICTING INVESTMENT?

China first introduced water pricing in 1985. Before this, water was deemed to be a public good, where no individual could be excluded from having the free use of the resource. The Central Government in Beijing directed China's water strategy, but over time the role was decentralized, and it came under the relevant provincial bodies. Water tariffs have risen moderately over time but do not reflect the true cost of supply. Low water pricing has created reluctance to improve water infrastructure.[132]

In Guangdong, the cost of sewage treatment to the authorities is RMB 1.1 per cubic metre, which is substantially higher than the newly introduced water tariff of RMB 0.8 per cubic metre.[133]

Worse still is that many sewage treatment plants are not put into operation. A 2004 survey of sewage treatment plants built since 2001 by the State Environmental Protection Agency (which has now been upgraded and renamed the Ministry of Environmental Protection) found that only 50 per cent of them were actually functioning, and the others were closed down because local authorities considered them too expensive to operate.[134]

One of the major impacts of under-priced water is that local authorities are often reluctant to connect sewage treatment works, which are typically financed by project-specific capital investment, with residential and industrial pollution sources. Local networks and the management of water treatment services are generally funded from local tax revenues, and since prices are set below the cost of treatment, there is widespread reluctance to close the loop.

ALLOCATION OF WATER FROM THE DONGJIANG

With rapidly expanding industrial sectors and burgeoning populations, the Dongjiang now supplies fresh water to over 40 million people in Heyuan, Huizhou, Dongguan, Guangzhou, Shenzhen, Hong Kong, and other cities. [135] The first Dongjiang water allocation plan was issued by the Guangdong Provincial Government in 2008, as a measure to forestall emerging conflicts over water between cities along the river.

Recognizing that this competition was likely only to intensify and that there was a finite limit to how much water could be withdrawn sustainably, the Guangdong Provincial Government has capped the amount of water to be taken from the Dongjiang at 10.7 billion cubic metres per annum.[136]

Figure 18 shows the percentage of water allocation of the Dongjiang during a normal water year (the Guangdong Government have also released allocated amounts of water during a dry water year). Whilst each of the Guangdong city's allowance decreases during dry water years, Hong Kong's assigned amount of 1.1 billion cubic metres per year remains the same. To date this policy remains unchanged; in October 2009 the Guangdong authorities confirmed that Hong Kong's maximum permissible allocation would remain in place, even though the drought might cause shortages in other cities dependent on the Dongjiang for their water.[137]

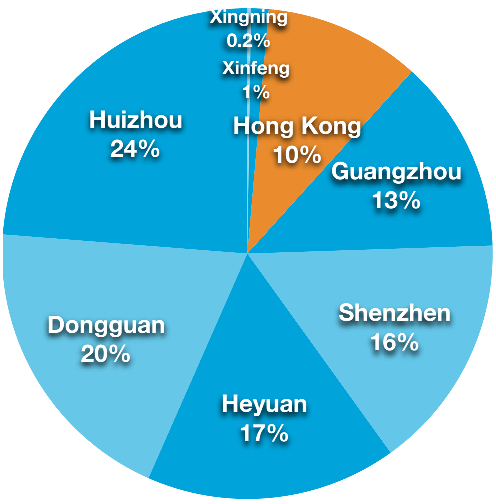

Figure 18: Dongjiang water allocation arrangements to assigned cities (normal year)(2008)

Data source: Government of Guangdong Province (2008)[139]

Despite this measure, a PRD forecasting study in 2004 showed that the region's water demand will continue to exceed its supply capacity, with high industrial consumption cited as the principal cause. It also projected an increase of over 50 per cent in total water demand for the region from 2002 to 2020 (excluding Hong Kong and Macau).[138] Figure 18 shows that competition for the Dongjiang's water is fierce, which adds weight to the argument that Hong Kong should consider options to reduce its current dependence on water from that source.

PART 4
Hong Kong's Water Management

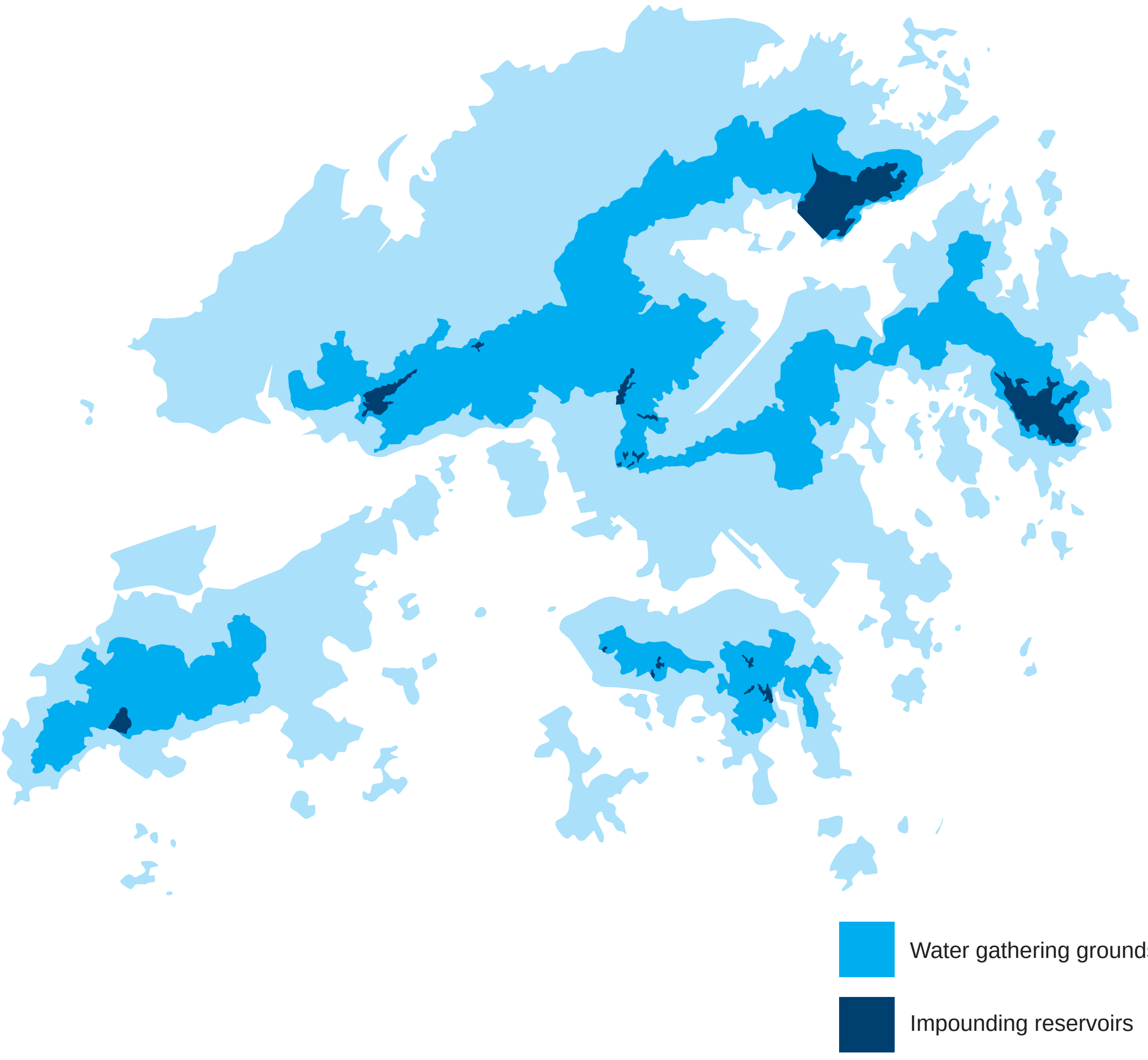

Figure 19: Reservoirs and water gathering grounds in Hong Kong
Source: adapted from WSD (2008)[140]

HONG KONG'S WATER MANAGEMENT

The current official position of the HKSAR Government is that there is 'no imminent need' to seek new water resources.[141] While this may be true for now, it is inescapable that Hong Kong is hugely dependent on the good health of the Dongjiang for direct water supplies and the whole of the Pearl River Basin indirectly for water services for its wider food and industrial needs. Moreover, water supply is a finite resource, and there is competitive demand from cities and counties in the PRD, and the effects of climate change will increase water stress for the whole region. Hong Kong's own source of water, its reservoirs and catchment, hold only about six months of supply.[142]

Total Water Management

Responding to these concerns, the WSD introduced a Total Water Management (TWM)[143] programme in 2008, which will run to 2030. The programme incorporates four main areas: new water resources, water conservation, water reclamation, and management of water resources. The main aspects of the programme are set out in terms of supply and demand for water:

Water supply management:

- To actively consider the reclamation of water (including rainwater harvesting and the reuse of grey water);
- To develop the option of desalinating sea-water; and
- To improve protection of water resources.

Water demand management:

- To increase public education on water conservation;
- To encourage use of water saving devices;
- To increase water leakage control by replacing and repairing old water mains and applying new technology to improve the detection of leakage and pressure management; and
- To expand the use of sea-water for toilet flushing.

There are several activities the WSD is implementing:

1 WATER CONSERVATION

The water conservation campaign aims to promote the use of water-saving taps and other devices to the general public, including in schools. The campaign refers to the challenges of water scarcity around the world and the need to use water carefully. The programme includes the development and implementation of a Water Efficiency Labelling Scheme to help consumers choose water-saving devices, such as low-flow showerheads.[144] Starting in 2008, the HKSAR Government is retrofitting government buildings and schools with water-saving devices at an estimated cost of HK$164 million.[145]

2 WATER RECYCLING

Water reclamation aims to replace high quality water currently used for non-potable purposes, such as toilet flushing and landscape irrigation, with lower quality water. Lower quality water is referred to as grey water and can be collected from baths, showers, wash basins, and kitchen sinks, which can then be treated and reused. A pilot scheme provides water from Shek Wu Hui Sewage Treatment Works for toilet flushing and gardening for residents in Sheung Shui and Fanling. The interim results noted that the public response was positive. The scheme will save 21 million cubic metres of water annually until 2030, or 1.5 per cent of total water use in Hong Kong.[146] As seen in Box 6, Singapore's reclamation plan is more extensive and ambitious. In the eight years since the commissioning of their water scheme in 2000, reclaimed water supplied 15 per cent of their total water,[147] or 516 million cubic metres per year. Singapore is on track to achieve 30 per cent by 2010.[148]

The HKSAR Government is also encouraging private developers in Hong Kong to adopt water reclamation schemes. A new MTR Corporation development in Tseung Kwan O will reuse grey water and collect rainwater for irrigation, street cleaning and water features. The WSD will also conduct trial schemes reusing grey water and rainwater harvesting for some new public projects.

3 REHABILITATING AND REPLACING WATER MAINS

The WSD is currently rehabilitating and replacing old water mains across Hong Kong. This is a 15-year programme that started in 2000. It aims to upgrade 3,000 kilometres of water mains in a multi-stepped programme that will reduce leakage from 25 per cent to 15 per cent[149] when completed. The next phase of upgrade is expected to deal with a further 4,700 kilometres of mains. In terms of volume, by 2030, Hong Kong will save 85 million cubic metres of water annually.[150]

DESALINATION

The WSD has built pilot desalination plants with a daily capacity of 240 tonnes at Tuen Mun and Ap Lei Chau, which use reverse osmosis technology to process fresh water from sea-water. The pilot tests were completed in 2007, confirming the technology is viable for Hong Kong.[151] Based on the initial findings, the unit production cost of the desalinated water was estimated to be HK$7.8 to HK$8.4 per cubic metre. These costs include construction of the plants (52% of production cost) and it is unclear what the long-term operational costs may be. The cost for desalinated water in the US is around HK$4 per cubic metre; the cost for a new plant in Shenzhen is projected to be around HK$6 per cubic metre; and the Tianjin Plant in Guangdong costs HK$4-5 per cubic metre.[152] At the time of writing this report, the HKSAR Government has made no decision on whether or how to proceed with desalination.

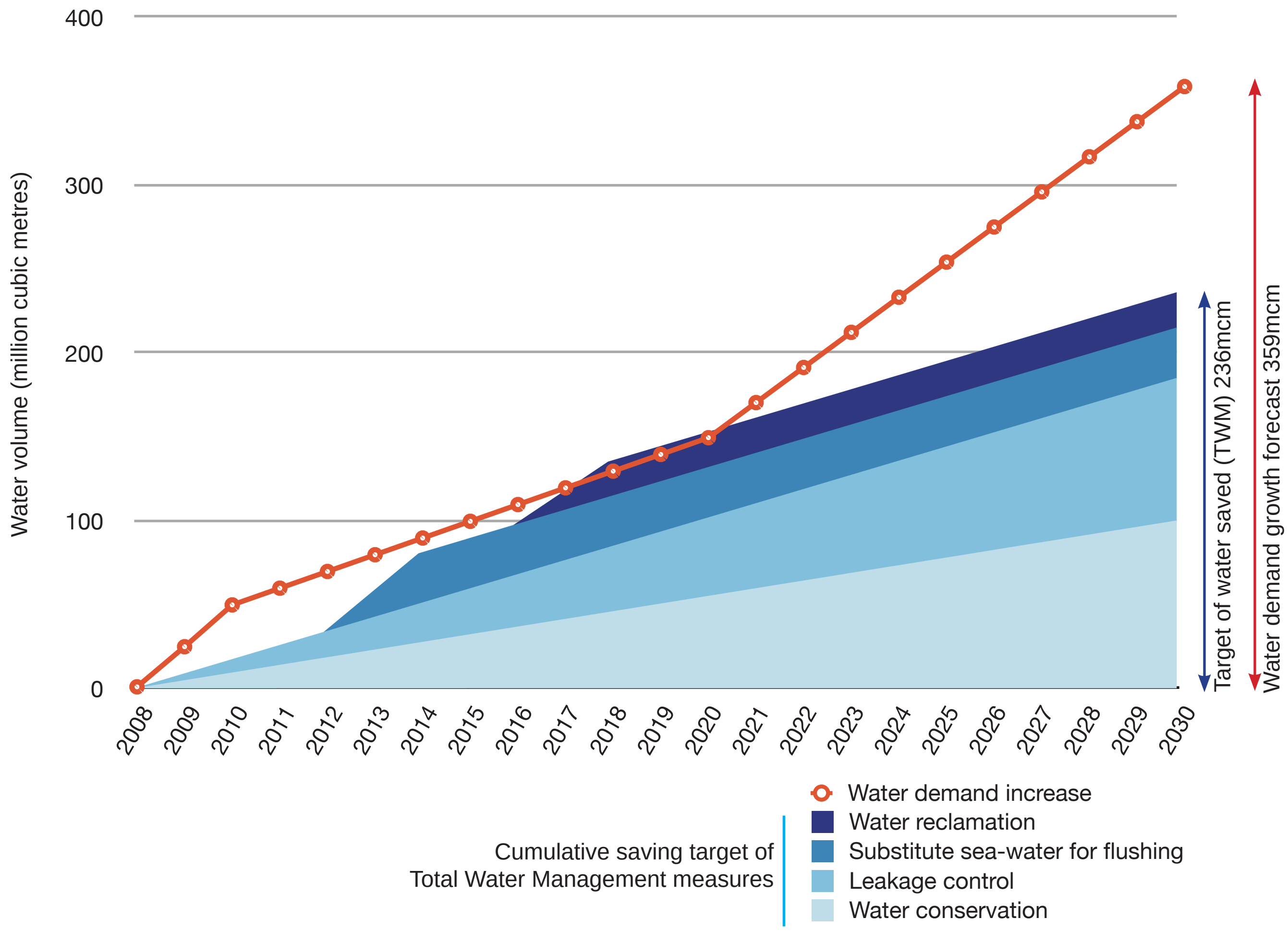

Figure 20: Hong Kong water saving target vs. fresh water demand growth forecast

Source: WSD (2008)[153]

The WSD has forecast that fresh water demand in Hong Kong in 2030 will reach 1.31 billion cubic metres,[154] which is 360 million more than today. This additional amount far exceeds the projected savings from the TWM programmes, which raises the question of how the gap will be filled. So far, this important subject has not attracted the attention it deserves. The WSD's existing programmes rely heavily on public education to achieve reduction targets, but they do not deal with every aspect of the entire water system. For example, they emphasize the reduction of fresh water consumption, but not total water consumption and reduction of wastewater. Low-hanging fruit includes promoting the installation of dual-flush cisterns for toilets, a common solution elsewhere to reduce water use and wastewater generation.

In 2004, a local study compared using sea-water and onsite reclaimed water for non-potable uses in residential developments. Calculations showed that in a standard residence, wastewater from bathing, hand washing, and laundry should produce not only enough reclaimed water for toilet flushing but also a substantial surplus. This surplus could then supply water for landscape irrigation, street cleaning, and other uses for a given residential development. If the right system could be put in place, the development would produce half the sewage that would need to be treated conventionally since the other half would be reused.[155]

The WSD's research and approach is laudable within the department's limited terms of reference. Its job within the HKSAR Government is supplying water. For Hong Kong to do much more would require the Government as a whole to treat water much more seriously and devise a long-term integrated water strategy that touches upon land use, pollution control, and collaboration with the Mainland, in addition to the work done by the WSD. Unfortunately, at the time of writing this report, there is still no policy interest or focus on exploring the potential to improve the water gathering and storage network, as summarized in this WSD statement:

> ***'The TWM Study has looked into options of new water resources though there is no imminent need. The option of expanding water gathering grounds and reservoirs storage is considered to be very low priority for Hong Kong because of the high costs and negative environmental impacts.'***[156]

BOX 6: ALTERNATIVE SUPPLY - SINGAPORE AS A CASE STUDY

Historically both Hong Kong and Singapore relied on purchasing water from their northern neighbours to meet rising demands for fresh water.[157] However, over the past 40 years Singapore has adopted a series of aggressive strategies to reduce its dependency on water from Malaysia. It has invested heavily in technology and research, and encouraged the community to be more involved in managing water.[158] Some of the main targets include:

- Increasing Singapore's catchment areas from 50 to 67 per cent of current land surface;
- Increasing water supply from alternative sources (e.g. water reclamation and desalination) to meet 25 per cent of Singapore's water demand;
- Ensuring that the quality of water continues to meet international standards;
- Reducing domestic water consumption per person to 155 litres a day by 2012; and
- Partnering the civic, public, and private sectors to create more awareness of the significance of enjoying, valuing and conserving water, and developing a sense of common ownership of water resources.

WATER SOURCES

Singapore's sources of water are known as the Four National Taps:[159]

1
Imported water

Singapore has been importing water from Malaysia under two separate agreements, which are due to expire in 2011 and 2061.[160]

2
NEWater

Used water is treated and further purified using sophisticated membrane technologies, making the water clean and safe to drink. NEWater has passed over 30,000 scientific tests and exceeds the most stringent requirements of the World Health Organization's Guidelines for Drinking Water Quality. Singapore currently has four NEWater factories (and plans to build a fifth) that produce 32 million gallons of NEWater per day. NEWater is primarily supplied to industrial and commercial customers in the electronics and power generation, water fabrication, and air-cooling sectors, making more potable water available for domestic consumption. Currently, NEWater meets 15 per cent of Singapore's needs. However this figure will rise to 30 per cent upon completion of the fifth water plant. Singapore's national water agency, the Public Utilities Board (PUB) also mixes a small amount of NEWater into the reservoirs. NEWater has been an important pillar of Singapore's sustainable water supply since 2003.[161]

Image by Kester Tay

CONSERVATION

Complementing its source diversification strategy, Singapore has also worked hard to manage consumption rates. In 2003, daily per capita consumption stood at 165 litres a day. This figure now stands at 157 litres, and Public Utilities Board (PUB) aims to reduce this to 155 litres by 2012 with a varied water conservation plan that encourages consumers to use water wisely: [164]

HOMES

***The 10-Litre Challenge* – PUB encourages every person to decrease their daily water use by ten litres. Water saving habits include: monitoring water bills, taking shorter showers, washing up in a filled sink, washing clothes in a full load, reusing rinse water, repairing leaks promptly, and half-flushing.**

***Water Efficient Homes* – This programme helps residents to conserve water at home and lower their water bills through practicing good water saving habits and installing water saving devices. PUB officers visit homes to install water saving devices at no extra cost to the resident.**

***Water Volunteer Programme* – PUB works actively with different groups, councils, and schools to form Water Volunteer Groups. These encourage residents to reduce their water usage through the 10-Litre challenge, education and installing water saving devices. Volunteers also visit lower-income and needy families to help them save on water bills. In the more than 40 constituencies that have formed these groups, households been able to reduce water usage by five to ten per cent.**

BUSINESS

***The 10% Challenge* – The business sector uses 43 per cent of Singapore's water. Lowering water consumption decreases operating costs and reduces the load on local water resources.[165]**

3

Desalinated water

In 2005, Singapore opened a desalination plant with a capacity of 30 million gallons (136,000 cubic metres) of water a day. Recent advances in cheaper technology and membrane prices have made desalination a practical source of water supply. The treatment process involves sea-water undergoing pre-treatment to remove suspended particles, followed by reverse osmosis (which is the same technology used for NEWater). This produces pure water, which is then re-mineralised. This desalinated water is mixed with treated water before being supplied to industry and homes.[162]

4

Local catchment

With little land area and no natural lakes or aquifers to collect rainwater, Singapore has made the most of a network of canals, rivers, and drains that feed rainwater into its reservoirs. The Singapore Government plans to increase catchment coverage from 50 per cent to 67 per cent of total land area by 2009. It will achieve this ambitious objective by damming the Marina Channel to create Singapore's fifteenth and largest reservoir, with a catchment area of 10,000 hectares, one-sixth the size of Singapore.[163]

PART 5
Conclusion

CHINA'S WATER RISKS

China faces severe water challenges in the coming years, including water shortage, dropping groundwater levels, saline intrusion, water pollution, and increasing demand from agricultural, municipal, and industrial uses. These challenges need to be tackled through a national policy that is coherent and integrated both on the supply and demand sides of water management and that also targets behavioural change. Political and industrial leaders throughout the country need to have a better grasp of what the challenges are, how they arose and why it is critical to deal with them as a matter of priority. To be effective, they also need adequate resources and assistance to improve management capacity.

ENSURE RESILIENCE OF THE PEARL RIVER BASIN

South China is fortunate that water availability per capita is much higher than in the north. However, population increase, urbanization, industrialization, and inappropriate land use are leading to the decline of that favourable position. The PRD is a major production hub, where economic activities depend heavily on large quantities of water for power generation, and manufacturing activities for tens of thousands of factories. Moreover, water pollution poses a major threat to both human and ecological health.

It is critical for China's long-term economic, social, and environmental sustainability that the environmental quality of the Pearl River Basin does not deteriorate further. China cannot afford to have its third major and least corrupted river system go the way of the more seriously degraded Yellow River and problematic Yangtze River systems. Indeed, the conditions of the Pearl River Basin need to be urgently reversed and put on a much healthier path for the sake of long-term sustainability affecting the livelihood of hundreds of millions of people. This can only be done through a truly integrated system of water resource management to replace the current fragmented framework, where there are many conflicting management imperatives.

PROMOTE NATIONAL WATER MANAGEMENT REFORM

Include supply and demand side reform and administrative reform

The physical challenge of building and financing sufficient water-related infrastructure and operating them well to protect water bodies, minimize polluting discharges, dispose sludge from wastewater safely, monitor drinking water quality, and protect public and ecological health are hard enough to achieve. Regulating these functions in China, including reforming water pricing and charging for wastewater treatment, is confounded by the complex administrative structure and division of responsibility among myriad central level and local level agencies.

Include capacity building for planning and management

There are also significant planning and management capacity gaps to be filled to ensure there is sufficient expertise and experience to implement every aspect of the supply and demand sides of water management reform.

MONITOR AND REPORT ON PROGRESS

The Central Authorities are aware of the current disjointed system, which affects the whole country, and attempts are being made to improve it. In 2007, President Hu Jintao promoted overall institutional reforms, including water management, at the 17th National Party Congress, which then led to a measure of administrative reforms of government ministries and agencies the following year. Improved water management from an institutional perspective can be expected in the coming years. Moreover, the water treatment industry is one of the biggest beneficiaries of the national financial stimulus package announced in 2008, which will go some way to redress the longstanding neglect. The various water-related projects and their effectiveness need to be closely watched, monitored, and assessed, and attention also needs to be paid on filling management capacity gaps.

TAKE A REGIONAL WATER PLANNING APPROACH IN SOUTH CHINA

Include Hong Kong and Macau in existing systems

For the Pearl River, the key is to strengthen the role of the existing Pearl River Water Resource Commission. Hong Kong and Macau should be given an appropriate status to participate under the 'one country, two systems' principle. Moreover, the administrative structure of Guangdong Province, Hong Kong, and Macau is among the most complex in China, where a variety of administrative units, including two special administrative regions, enjoy various levels of functional responsibility. With so many agencies and administrative areas having some role in managing different aspects of the water system, effective coordination in policies, policy implementation and enforcement is a real challenge, even though the Guangdong Provincial Government recognizes the importance of taking a regional planning approach that involves inter-municipal cooperation and joint management of facilities in order to capture economies of scale and least-cost options. In the case of the evolution of the Dongjiang Water Allocation Plan, which affects eight cities and counties, including Hong Kong, regular dialogue is obviously critical to ensure there is a collaborative rather than competitive attitude.

Involve all stakeholders to devise and implement plan

A comprehensive water resource management plan where all relevant stakeholder units are involved, and where relevant data is publicly released annually, is urgently needed. Special attention needs to be paid to overall land use, water resource management, water conservation, water efficiency, ecological resilience, pollution control, and public health. Good water resource management will necessarily include making the water supply system more robust, for example, by capturing water more effectively and increasing storage capacity, pricing water to prevent wastage, especially in the industrial sector. Public awareness of the importance to water conservation must also be raised.

Additional benefits

There will be additional benefits arising from the reforms, which will include:

- Ensuring long-term water security to residents and industry;
- Capitalizing opportunities for water catchment management with conservation, conservation enterprises, and eco-tourism;
- Reducing cost in filtering and processing water for potable supply and high-end industrial uses, including avoiding water-related diseases and improving public health; and
- Transforming the PRD region into a 'green and quality living area', which is the region's stated policy goal, including Hong Kong.

ANTICIPATE CLIMATE CHANGE IMPACTS

In anticipation of the possible increase in frequency or intensity of both droughts and floods brought on by climate change, improved water storage and conservation infrastructure, and flood management systems will be needed. These will include reliable forecasting of weather and tides, a flood warning apparatus in vulnerable areas, and comprehensive emergency response. It is not too early to consider contingency planning to deal with potential damage to existing infrastructure, such as water supply pipes.

Prepare a climate change vulnerability and adaptation assessment

It is not too early for the Pearl River Water Resource Commission and all its stakeholders, including Hong Kong and Macau, to prepare a Pearl River Basin climate change vulnerability and adaptation assessment. This will enable relevant authorities and the public to understand their long-term future depends on managing water well. An assessment should include identifying vulnerabilities in water supply, agriculture, forests, wetlands, coastal areas, and cities, and what specific adaptation measures are needed.

HONG KONG NEEDS ITS OWN WATER POLICY

In the case of Hong Kong specifically, water needs to become a specific policy concern for the HKSAR Government. It needs to see its water supply within the context of south China, and it needs to ensure it has a place within the Pearl River Water Resource Commission and other relevant bodies. Within Hong Kong itself, apart from upgrading and repairing water mains, it needs to invest in water gathering and storage, as well as practice water reclamation for reuse and reduce sewage treatment for a start – in fact, these are low-hanging fruit. The HKSAR Government should form a special task force to review water-related issues and practices so as to ensure long-term sustainability.

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About the Organizations

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Civic Exchange is a Hong Kong-based non-profit public policy think tank that was established in October 2000. It is an independent organization that has access to policy makers, officials, businesses, media, and NGOs—reaching across sectors and borders. Civic Exchange has solid experience in air quality, energy, environment, urban planning, and climate change research, as well as economic and governance issues. Recent work in these areas includes studying Asian climate change negotiations and two books analysing the changes in Hong Kong's environmental and air quality policy since 1997. It has also hosted a series of forums on the relationship between energy policy, air quality, buildings and climate change.

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