

Geography

Learning and Teaching Resources on Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area)



Environmental Conservation

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1 Introduction

In the face of today's challenges on resource, energy and environment, environmental and economic sustainable development are the ways of development to be adopted and explored. Concepts of sustainable development and green development have gained much more attention by people as societies and economies develop. Finding a balance between people's quality of life, environmental protection and rapid economic growth through sustainable development has become the challenge that every city needs to face today.

The world-class bay areas are characterised not only by their rapid economic development, efficient transport facilities, clear regional development functions and the accumulation of innovative resources, but also their good ecological environment. High quality ecological environment can attract a large number of innovative industries and elements. At the same time, a comfortable climate, high forest coverage and livable environment are also important conditions for bay areas to attract talents. Therefore, in terms of environmental protection, the Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area) should work together to create and maintain a good ecological environment in the area and achieve sustainable development through regional cooperation.

2 The cooperation of ecological environmental protection in the Greater Bay Area

From the geographical aspect, the Greater Bay Area is located at the Zhujiang Estuary where land, rivers and the ocean meets and these form an inseparable ecosystem. The connected geographical boundaries, integrity of ecosystem and the environmental factors would determine the roles of different cities in the Greater Bay Area in environmental conservation and green development so as to solve the environmental problems. In terms of environmental management and sustainable development of green economy, cooperation has been around in the Greater Bay Area for a long time.

The environmental exchanges between Hong Kong and Guangdong began in the early 1980s. Under the joint conference system between Guangdong and Hong Kong, the “Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection”¹, which consists of a team of experts and eight special panels², was established. The key areas of cooperation of the working group include air quality management, forest protection, water quality protection in the Zhujiang Delta and Dongjiang, marine resource protection and marine environmental management, regional environmental management in Dapeng Bay and Deep Bay (Shenzhen Bay), enterprise energy conservation and clean production. In 2005, the “Guangdong-Hong Kong Pearl River Delta Regional Air Quality Monitoring Network” was established. The network is in line with international standards and work to monitor the regional air quality and to report the air quality index to the public. In 2014, Macao also joined the network. The Guangdong, Hong Kong and Macao Governments signed the *Cooperation Agreement on Regional Air Pollution Control and Prevention* in September 2014, and proposed to build an air quality monitoring platform for the Zhujiang Delta, to jointly report the regional air quality information, promote air pollution control and prevention, carry out environmental research work and strengthen environmental protection technology exchanges between Hong Kong, Guangdong and Macao. The key cooperation areas are shown in Table 1.

¹ “Hong Kong-Guangdong Environmental Protection Liaison Group” was established in 1990 to facilitate the co-operation in regional water quality management. In 1999, building on this foundation, the “Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection” was established to enhance cross-border environmental co-operation.

² The eight special panels are: (1) The Pearl River Delta (PRD) Air Quality Management and Monitoring Special Panel, (2) The Afforestation and Conservation Special Panel, (3) The Marine Resources and Conservation Special Panel, (4) The Pearl River Delta Water Quality Protection Special Panel, (5) The Mirs Bay and Deep Bay (Shenzhen Bay) Areas Environmental Management Special Panel, (6) The Dongjiang Water Quality Protection Special Panel, (7) The Hong Kong-Guangdong Energy Efficiency and Cleaner Production Special Panel and (8) The Hong Kong-Guangdong Marine Environmental Management Special Panel.

Table 1: Areas of environmental cooperation between Guangdong, Hong Kong and Macao

Year	Area of cooperation
1990	Under the joint conference system between Guangdong and Hong Kong, the “Hong Kong-Guangdong Environmental Protection Liaison Group” was established. In 2000, building on this foundation, the “Hong Kong-Guangdong Joint Working Group on Sustainable Development and Environmental Protection” was established to enhance cross-border environmental co-operation.
2005	The “Guangdong-Hong Kong Pearl River Delta Regional Air Quality Monitoring Network” with international standards was established and operated, which is also the first network of such kind in the country.
2013	Macao and Zhuhai signed the <i>Zhuhai-Macao Environmental Protection Cooperation Agreement</i> .
2014	In terms of solid waste treatment, the transfer of used vehicles from Macao to Guangdong was approved by the State Council.
	The <i>Cooperation Agreement on Regional Air Pollution Control and Prevention</i> was signed by the Guangdong, Hong Kong and Macao Governments.
2016	In terms of the development of the environmental protection industry, the Macao SAR Government and the Jiangmen Municipal Government signed a framework agreement for the construction of Daguang Bay Economic Zone to clarify the priority of “developing the equipment manufacturing industry and resource recycling environmental protection industry”.
	The Guangdong and Hong Kong Governments jointly signed the <i>2016-2020 Cooperation Agreement between Hong Kong and Guangdong on Environmental Protection</i> .
2017	The Department of Environmental Protection of Guangdong Province and the Environmental Protection Bureau of the Macao SAR Government signed the <i>2017-2020 Guangdong-Macao Environmental Cooperation Agreement</i> .

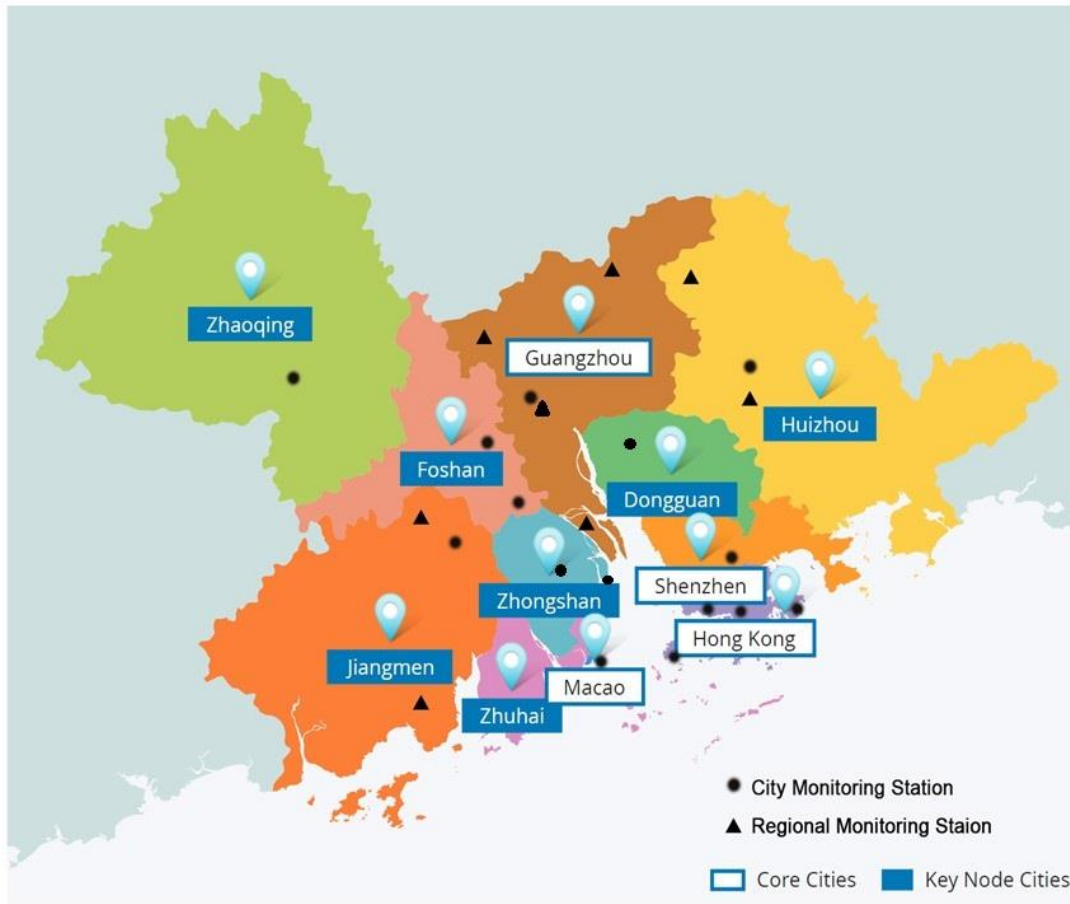
Source: consolidated press reports

3 Major environmental problems in the Greater Bay Area

3.1 Atmospheric environment

Changes in air quality, climate and ecological environment would always affect people's health. This is also a major world problem. Improving air quality is one of the goals for the three governments of Guangdong, Hong Kong and Macao. According to the UN report, the number of premature deaths caused by indoor and outdoor air pollution reaches millions each year. In addition to causing adverse weather conditions, climate change is also threatening global food security and biodiversity. As the atmosphere is closely connected, no cities or regions can stand alone. Therefore, the governments of Guangdong, Hong Kong and Macao jointly signed the *Cooperation Agreement on Regional Air Pollution Control and Prevention* on 3 September 2014 in order to strengthen inter-regional cooperation and to save the atmospheric environment in the Greater Bay Area. The agreement also provided more detailed real-time air quality monitoring for the residents of Guangdong, Hong Kong and Macao. The number of air quality monitoring stations has also increased from 16 to 23 (Figure 1).

Figure 1: Distribution of regional air quality monitoring stations in the Greater Bay Area



Source: Meteorological and Geophysical Bureau (Macao SARG) (2018)

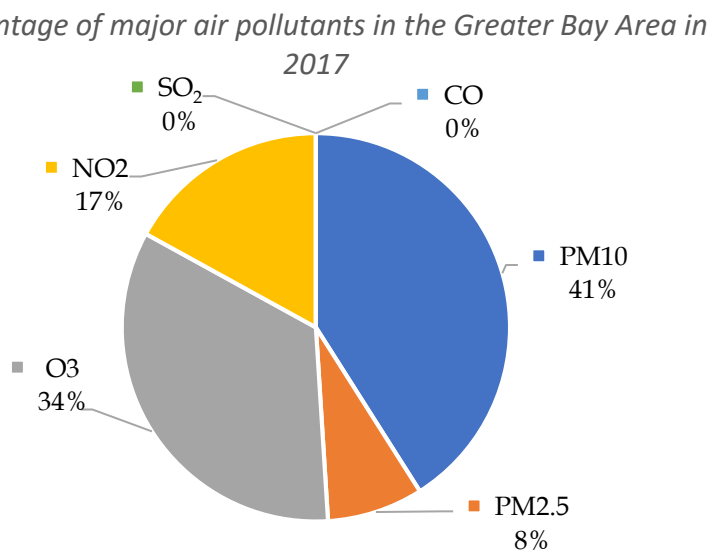
Air quality indicators for various air quality monitoring stations in the Greater Bay Area include a total of six pollutant concentrations, i.e. PM_{10} ³ (respirable suspended particulates with a diameter less than 10 microns), $PM_{2.5}$ ⁴ (respirable suspended particulates with a diameter less

³ **PM₁₀**: There are numerous sources of PM_{10} , including power plants, vehicles, vessels, cement plants, ceramic industries and dust. Some is formed by gaseous pollutants in the atmosphere during the oxidation (e.g. formation of sulphate particles from sulphur dioxide) or photochemical reaction. The PM_{10} may get deeper into the lungs and affect the respiratory systems of people. Moreover, the PM_{10} also poses significant impacts on visibility.

⁴ **PM_{2.5}**: $PM_{2.5}$ (fine suspended particulates) in the atmosphere is produced during the combustion at power plants and diesel vehicles. Some is formed by gaseous pollutants in the atmosphere during the oxidation or photochemical reaction. It poses very significant impacts on visibility.

than 2.5 microns), SO₂⁵ (sulphur dioxide), NO₂⁶ (nitrogen dioxide), O₃⁷ (ozone) and CO⁸ (carbon monoxide). In 2017, the major atmospheric pollutants in the Greater Bay Area was PM₁₀, followed by ozone, NO₂ and PM_{2.5} which occupied 8 - 41%. For the details of the distribution of air pollutants, please refer to the Pearl River Delta Regional Air Quality Monitoring Report produced by the Ecological and Environmental Monitoring Centre of Guangdong, Environmental Protection Department, Hong Kong SARG, Environmental Protection Bureau, Macao SARG and Meteorological and Geophysical Bureau, Macao SARG. (Website:https://www.epd.gov.hk/epd/sites/default/files/epd/english/resources_pub/publications/files/PRD2021_1-en.pdf)

Figure 2: Percentage of major air pollutants in the Greater Bay Area in 2017



Source: Department of Ecology and Environment of Guangdong Province (2017)

However, according to historical figures, the annual mean concentration of the six air pollutants in Guangdong Province were qualified as Class II of the national air quality standard in 2017.

⁵ **Sulphur dioxide:** Sulphur dioxide is formed primarily during the combustion of sulphur-containing ores and generated from power plants, fuel-burning installations, vehicles, vessels, etc. The sulphur dioxide not only affects people's respiratory systems but also forms sulphate particles in the atmosphere by oxidation, and this poses significant impact on regional pollution level, acid rain and visibility.

⁶ **Nitrogen dioxide:** Nitrogen dioxide is primarily formed by the nitric oxide emitted during the combustion. The sources include power plants, fuel-burning installations, vehicles and vessels. The nitrogen dioxide not only affects people's respiratory systems, but also forms sulphate particles in the atmosphere by oxidation, and this poses significant impact on regional pollution level, acid rain and visibility.

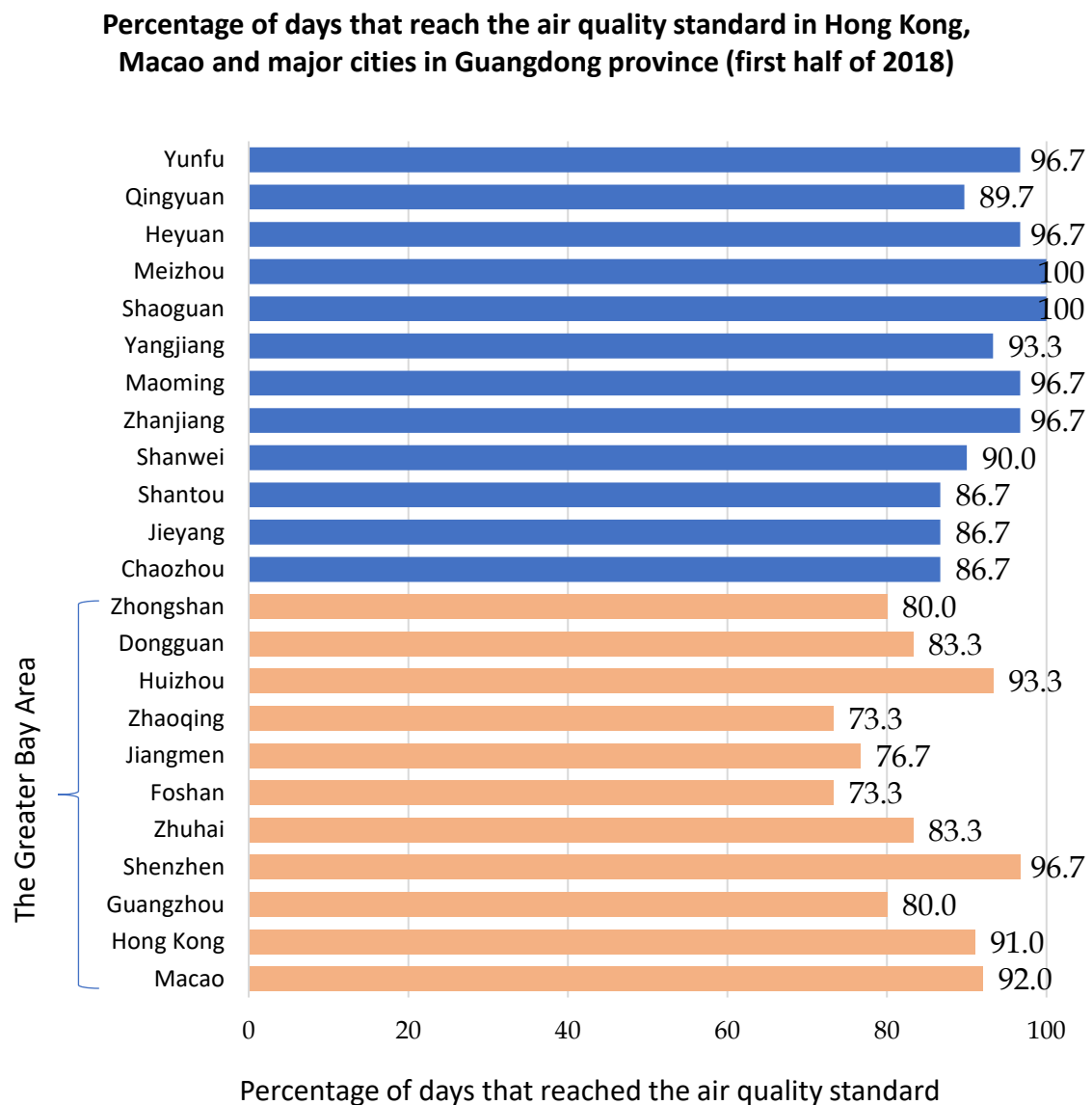
⁷ **Ozone:** Ozone is not directly emitted from pollution sources, but formed by some nitrogen oxides and volatile organic compounds during the photochemical reaction. It is the main component of photochemical smog. Ozone can irritate the eyes, nose and throat, and the high concentration of ozone can aggravate pre-existing respiratory illnesses (e.g. asthma).

⁸ **Carbon monoxide:** Carbon monoxide is produced by incomplete combustion of fuels. Apart from natural sources such as methane conversion, plants and wildfires, carbon monoxide is primarily produced by deforestation as well as the combustion of grassland, waste and fossil fuels. Vehicles are the major source of carbon monoxide.

The air quality has met the standard for three consecutive years, which was ahead of the Beijing-Tianjin-Hebei area and the Changjiang Delta region.

In the major cities of the Guangdong Province, Hong Kong and Macao, 88.8% of the days in the first half of 2018 reached the air quality standard. Among cities in the Greater Bay Area, Zhaoqing (73.3%) and Foshan (73.3%) had the lowest ratio while Shenzhen has the highest (96.7%) (Figure 3). However, considering the whole Guangdong Province, the cities in the Greater Bay Area had the lowest ratio (approximately 83.9%) while the northern part of Guangdong Province (including Yunfu, Qingyuan, Heyuan, Meizhou and Shaoguan) had the highest (96.6%). Table 2 shows the air pollution problems in the nine Mainland cities of the Greater Bay Area.

Figure 3: Percentage of the days that reach the air quality standard in Hong Kong, Macao and major cities in Guangdong province (first half of 2018)



Source: Meteorological and Geophysical Bureau (Macao SARG) (2018)

Table 2: Air pollution problems in the nine Mainland cities of the Greater Bay Area

City	Major excessive pollutants	Main air quality problems	Sources of pollutants and key industries	Problems related to socio-economic development
Guangzhou	PM _{2.5} , O ₃ , NO ₂	Compound pollution; The PM _{2.5} and O ₃ concentrations are not up to standard	Thermal power generation, cement manufacturing, chemical engineering, transportation, port shipping, textile industry	(1) There are many industrial enterprises and they are widely distributed. Energy consumption is still dominated by coal and oil products. (2) In the tertiary industry, transportation and catering services account for a large proportion while modern service industry accounts for a low proportion.
Shenzhen	PM _{2.5} , O ₃	Currently, the concentration of all air pollutants reach the standard of the <i>Action Plan on Prevention and Control of Air Pollution</i> .	Thermal power generation, furniture, printing, containers, automobiles, home appliance manufacturing, port shipping	The economy is well-developed, and the economic restructuring is at the forefront of other cities.
Zhuhai	PM _{2.5}	Currently, the concentration of all air pollutants reach the	Thermal power generation, paper making, furniture, oil transportation	The economy is relatively developed, and Zhuhai is currently enhancing

		standard of the <i>Action Plan on Prevention and Control of Air Pollution</i> .	and warehousing, synthetic materials manufacturing, paint manufacturing, plastic products	its production structure.
Foshan	PM _{2.5} , O ₃ , NO ₂	Compound pollution; The PM _{2.5} concentration is not up to standard; Smog pollution is serious.	Thermal power generation, ceramics, textile, paper making, furniture, printing, coatings, ink manufacturing, home appliance manufacturing	(1) There are many industrial enterprises and they are widely distributed. (2) The transportation industry is well-developed that the freight vehicles emit large amount of pollutants.
Dongguan	PM _{2.5} , O ₃ , NO ₂	Compound pollution; The PM _{2.5} and O ₃ concentration are not up to standard.	Thermal power, paper making, textile, rubber and plastic products, chemical raw materials manufacturing, furniture, footwear	(1) The economy is well-developed. There are many enterprises, and they are widely distributed and scattered. (2) It is hard for industrial transformation and upgrading.
Zhaoqing	PM ₁₀ , PM _{2.5} , O ₃	Prominent compound pollution; The PM _{2.5} and O ₃	Ceramics, cement, textile, non-ferrous metal smelting, chemical engineering	(1) Concentration of relocated industries from other cities (2) Pollution control and monitoring lag

		concentrations exceed the normal standard.		behind the industrial development.
Zhongshan	PM _{2.5}	The annual mean concentration of PM _{2.5} exceeds the normal standard; Prominent impact of O ₃ .	Thermal power, paper making, textile, furniture, home appliances, printing, coating chemicals	The economy is well-developed. There are many enterprises, and they are widely distributed and scattered.
Jiangmen	PM _{2.5}	The concentration of PM _{2.5} largely exceeds the normal standard; The air quality is easily affected by the pollutants emitted from surrounding cities	Thermal power generation, textile, paper industry, plastic synthesis, furniture manufacturing	—
Huizhou	PM _{2.5}	Currently, the concentration of all air pollutants reach the standard of the <i>Action Plan on Prevention and Control of Air Pollution</i>	Refining and petrochemical, chemical raw materials, chemicals, cement, container manufacturing, printing, furniture	(1) Refining and petrochemical and downstream industries are still expanding (2) It is challenging in controlling new pollutants.

Source: Department of Ecology and Environment of Guangdong Province (2016)

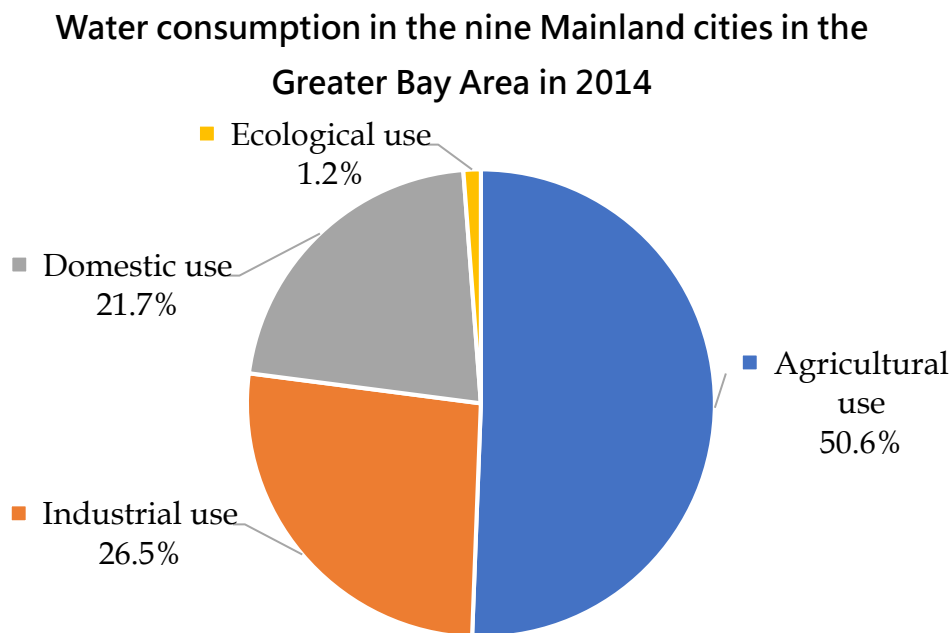
3.2 Water Environment

The Greater Bay Area is located at the river network area of the Zhujiang Delta, which is influenced by various factors such as tides and sluices. River channels in the area are crisscrossed and the hydrology is complicated. Since the late 1980s, rapid population growth due to industrialisation and urbanisation in the Greater Bay Area has led to the continuous rise of domestic and industrial sewage discharge. However, due to the lack of advanced sewage treatment facilities, the hydrological environment in the area continued to deteriorate. In recent years, the regional hydrological environment has improved, but the water bodies in some cities is still seriously polluted. In particular, Shenzhen River, Shima River and the rivers at Guangzhou-Foshan border are heavily polluted.

Normally, water is mainly utilised in three ways: production (including industrial production and agricultural irrigation), everyday life (urban and rural domestic water), and ecological water consumption⁹ (rivers, lakes and reservoirs). According to the statistics of Guangdong Province in 2014, water in the nine Mainland cities of the Greater Bay Area is mainly used for production (76.9%), of which agricultural water consumption is the highest, accounting for 50.6% of the total water consumption, followed by industrial water (26.5%) and domestic water consumption (21.7%). The ecological water consumption is the lowest, accounting for only 1.2% of the total water consumption.

⁹ Ecological water consumption refers to the consumption necessary to maintain the normal and relative stability of various ecosystems within a specific range, and ecological water will not be used for social and economic purposes. Existing water resources include surface water, groundwater and soil water, etc.

Figure 4: Water consumption in the nine Mainland cities of the Greater Bay Area in 2014



Source: Department of Ecology and Environment of Guangdong Province (2016)

Water pollution is one of the negative impacts resulted from the rapid industrial and economic development of the Greater Bay Area. According to the *Implementation Plan of Creating Clearer Rivers in South Guangdong (2013-2020)*, water in the Greater Bay Area is mostly derived from large rivers of Dongjiang, Xijiang, Beijiang and other river networks in the Zhujiang Delta river networks (Table 3). Although the water quality of the major rivers in the Greater Bay Area is generally good and consistent, there are still water bodies with Class Poor V. Since 2004, drinking water in the Greater Bay Area has gradually improved, while the water quality of the water sources for urban use has met the standards. According to the requirements of the 13th Five-Year Plan of Guangdong Province, the Greater Bay Area will strive to not having any water bodies classified with Class V by 2020 (Table 4).

Table 3: Main water supply channels in the Greater Bay Area

River	Water system	Main service area
Zhujiang	Xijiang	Macao, Guangzhou, Zhuhai, Foshan, Zhongshan, Zhaoqing, Jiangmen
	Beijiang	Guangzhou, Foshan, Shaoguan (Non-Greater Bay Area City), Qingyuan (Non-Greater Bay Area City)
	Dongjiang	Hong Kong, Guangzhou, Shenzhen, Heyuan (Non-Greater Bay Area City), Huizhou, Dongguan
	River Networks of the Zhujiang Delta	Foshan, Zhongshan
	Others	Guangzhou, Huizhou, Jiangmen

Source: Department of Ecology and Environment of Guangdong Province (2016)

Table 4: Proportion of water bodies (%) with Class Poor V¹⁰ in the nine Mainland cities of the Greater Bay Area

City	2014	2020
Guangzhou	0	0
Shenzhen	70.0	0
Zhuhai	0	0
Foshan	11.1	0
Jiangmen	0	0
Zhaoqing	0	0
Huizhou	0	0
Dongguan	0	0
Zhongshan	0	0

Source: Department of Ecology and Environment of Guangdong Province (2016)

¹⁰ "Surface Water Environmental Quality Standard" is a mandatory standard and will be promulgated on April 26, 2022. Class Poor V water refers to water that has a pollution level that exceeds Class V.

3.3 Solid waste

Proper use and disposal of solid waste is one of the important measures to prevent environmental pollution, and is a key to improve the overall quality of water, atmosphere and soil. Under the concept of sustainable development, waste management is an important environmental issue that governments need to face today. In addition to selecting suitable waste treatment methods, efficient waste collection and transportation is also important for controlling the environmental problems associated with waste disposal.

Solid wastes mostly come from cities. Solid waste mainly includes domestic waste, industrial and commercial waste, construction waste, and some special and dangerous wastes such as electronic waste, medical waste and hazardous waste. Domestic, industrial and commercial waste can generally be incinerated while hazardous waste and electronic waste need to be dismantled and landfilled.

Guangzhou, Zhuhai, Foshan, Huizhou, Jiangmen and Zhaoqing have established special solid waste management agencies to improve the capacity of these cities in solid waste management. However, economic development and rising urban population in the Greater Bay Area has caused the amount of hazardous waste to grow rapidly. Governments in the Greater Bay Area will be facing immense challenges in solid waste management. Some scholars have put forward the following suggestions: (1) to increase the use of industrial waste in the Greater Bay Area, strengthen the control of its source, promote clean production among industrial enterprises, implement mandatory cleaning inspection for enterprises that produce high volume of waste disposal or serious pollution, and to upgrade the production structure and develop advanced technology; (2) to implement a hazardous waste declaration system and strengthen the planning and management of hazardous wastes, to ensure the safe disposal of hazardous wastes; (3) to improve harmless treatment of sludge and incineration dust, increase the dewatering rate of sludge at sewage treatment plants, and make full use of coordinated facilities such as thermal power plants, waste incineration plants and cement plants to reduce secondary pollution; (4) to strengthen the recycling and use of dismantled electronic waste, and improve the dismantling

capacity of used electrical and electronic goods.

4 Challenges of Cooperation in Environmental Protection in the Greater Bay Area

Social systems often result in variations in the mode of environmental protection and governance. The difference in socio-economic development also leads to different demands for environmental protection. These are the major challenges of environmental protection and cooperation in the Greater Bay Area.

4.1 Differences in environmental protection and governance

The Greater Bay Area is featured by “one country, two systems, three jurisdictions”. Due to the differences in social systems and institutions, different cities in the Greater Bay Area have their own environmental protection departments and judicial systems. Therefore before strengthening the cooperation between cities, the differences among cities on environmental protection concepts, systems, means, technology and supervision have to be addressed first.

4.2 Different aspirations for environmental protection

Currently, production and consumption pattern in Hong Kong and Macao are mostly service-oriented, while the Zhujiang Delta region of Guangdong Province is still in the stage of industrialisation as well as in the process of transforming from labor-intensive industries to modern high-tech industries. Consumption pattern should change from product consumption to a green economy with energy conservation and emission reduction. Based on the differences in production and consumption patterns, the governments and citizens of Hong Kong, Macao and Mainland cities have differences in the demands on environmental issues, industrial governance and environmental protection programmes. In the future, cooperation in the Greater Bay Area needs to take a “different but harmonious” approach.

5 Conclusion

A good environment is the foundation for building a world-class bay area. The bay area relies on the bay, which is open and geographically beneficial to economic development. It also has rich biological and environmental resources as well as unique geographical landscapes and ecological value. If the environment deteriorated, the bay area will lose its foundation for development.

Due to the industrial development of the Greater Bay Area, the discharge of pollutants has been rising in recent years. The concentration of major air pollutants in the Greater Bay Area is higher than that of the other parts of Guangdong Province. Tributaries in urban areas with lower river discharge or flow in the Zhujiang Delta are moderately polluted (Class V). Solid waste pollution and waste disposal are also the challenges to the sustainable development of the Greater Bay Area. To solve the environmental problems, local governments in the Greater Bay Area should cooperate while enterprises and residents in the Greater Bay Area should reduce the pollution from the source. Only through cooperation of different parties, the Greater Bay Area can continue to develop in a sustainable manner and strike a balance between the environment, society and economy.

The National Development and Reform Commission is leading the relevant departments in the preparation of the preliminary report of the environmental protection plans of the Greater Bay Area. In the near future, the first draft of the development plan related to the environmental protection in the Greater Bay Area will be released, and the public will be widely consulted. In addition, the governments of the Greater Bay Area are actively promoting environmental and technological innovation, to help resolve the environmental issues in the area.

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