

13

**GEOGRAPHY, ENVIRONMENT AND POPULATION**



## Geography, Environment and Population

### Location

The Macao Special Administrative Region (MSAR) is an integral part of the People's Republic of China. Situated at the mouth of the Pearl River Delta (PRD) and bordering on Guangdong Province, Macao is 60 kilometres from Hong Kong, and located at latitude 22°12'40"N and longitude 113°32'22"E. Macao time is eight hours ahead of Greenwich Mean Time. The MSAR consists of the Macao peninsula and two islands: Taipa and Coloane. Three bridges – Nobre de Carvalho Bridge, Friendship Bridge (Ponte da Amizade) and Sai Van Bridge – link the peninsula to Taipa; while the COTAI Reclamation Area links Taipa and Coloane islands.

According to Chief Executive Notice No.128/2015 dated 20 December 2015: as stipulated in Order No. 665 of the State Council of the People's Republic of China, the Macao Special Administrative Region comprises land and marine areas, with the land area comprising the Border Gate Macao Checkpoint Building section and the Canal dos Patos section, and the marine area comprising six sections: the Inner Harbour section, Cotai channel section, southern Macao waters section, eastern Macao waters section, artificial island section, and northern Macao waters section. The boundary to the west is meridian 113°31'41.4"E, to the east 113°37'48.5"E, to the south parallel 22°04'36"N, and to the north 22°13'01.3"N.

### Area

Due to reclamation along its coastline, Macao's total land area has grown from 11.6 square kilometres in 1912, when measurements were first taken, to 30.5 square kilometres in 2016. The Macao peninsula accounts for 9.3 square kilometres (30.5 percent) of the current area, Taipa island for 7.6 square kilometres (24.9 percent), Coloane island for 7.6 square kilometres (4.9 percent), COTAI Reclamation Area for six square kilometres (19.7 percent), and the new campus of the University of Macau for one square kilometre.

According to Chief Executive Notice No.128/2015 dated 20 December 2015: as stipulated in Order No. 665 of the State Council of the People's Republic of China, the Central People's Government explicitly determines that the area of waters of the Macao Special Administrative Region is 85 square kilometres.

### Geology and Topography

Macao mainly comprises flat land, terraces and hills. The area of flat land (including reclaimed land) is 21.4 square kilometres, accounting for 70.2 percent of the total; granite hills cover six square kilometres, or 19.7 percent; and terraces cover 1.2 square kilometres, or 3.9 percent. The terraces are historically areas of denudation, extending along St Augustine, Luis de Camoes Garden, the hill behind Mong Ha Kun Iam Tong Temple, Russa Hill, and the southern part of Taipa island. Their relatively small area, low elevation (20-25 metres) and gentle slopes mean that most of the terraces are fully utilised. The remaining land – including reserves, monument sites and forests – occupies approximately 1.9 square kilometres, accounting for 6.2 percent of the total land area.

The elevation of Macao increases from the north to the south. Guia Hill, in the north, is the highest point on the Macao peninsula, with an altitude of 90 metres. To the south, Alto de Coloane is the highest hill on Coloane island, as well as the highest point in Macao, with an altitude of 170.6 metres. Taipa Grande, the main peak of Taipa island, has an altitude of 158.2 metres.

## Coastline

Macao is a typical coastal area, with 50.4 kilometres of coastline, of which 14.6 kilometres is around the Macao peninsula, 35.8 kilometres is around the two islands and 1.7 kilometres is around the new campus of the University of Macau.

## Climate

Macao is situated in a subtropical zone, with the Asian continent to the north and a wide tropical sea to the south. In winter, Macao experiences northerly winds, cold and dry weather and low rainfall, due to a cold continental high-pressure system at medium and high latitudes. In summer, Macao is mainly subject to south-westerly winds, hot and wet weather and heavy rainfall, due to the influence of oceanic tropical weather systems. The reverse of wind directions in winter and summer, together with minimal temperature variations during the day, give Macao a marine monsoon climate.

According to the climate normals of the World Meteorological Organization (WMO) calculated with 30 years of data, the average annual precipitation in Macao between 1981 and 2010 was more than 2,000 millimetres, with most rainfall occurring between April and September. June had the most precipitation – an average of 363.8 millimetres – while January had the least – an average of 26.5 millimetres.

Macao has an average annual temperature of 22.6°C. The coolest month is January, when it averages 15.1°C. Most years, Macao has a short cold weather period when temperatures fall below 5°C. The average monthly temperature exceeds 22°C during seven months of the year, indicating that Macao has a short winter but a long summer.

Macao is frequently hit by typhoons. The typhoon season starts in May and ends in October, with July to September as its peak period.

## Weather Overview

### General Situation

In 2016, Macao's average annual temperature was the same as the climate normal and the relative humidity was slightly higher than the climate normal, while the total rainfall was significantly higher than the climate normal, and the total evaporation level and total hours of sunshine were significantly lower than the climate normal.

Eight tropical cyclones affected Macao in 2016. They were: a tropical depression from 26 to 28 May, Tropical Storm Mirinae from 26 to 27 July, Typhoon Nida from 1 to 2 August, Tropical Storm Dianmu from 17 to 18 August, Typhoon Meranti from 14 to 15 September, Tropical Storm

Aere from 7 to 9 October, Typhoon Sarika from 16 to 19 October and Typhoon Haima from 20 to 21 October. Typhoon Signal No. 8 was issued as a result of Typhoon Haima, and the yellow storm surge warning was issued as a result of Typhoon Nida and Tropical Storm Dianmu.

<b>Summary of Severe Weather Warnings Issued in 2016</b>			
<b>Warning/Signal Type</b>		<b>Frequency</b>	<b>No. of Warning Reports Issued</b>
Tropical Cyclone Warning	No. 1 Alert Signal	8	38
	No. 3 Strong Wind Signal	5	28
	No. 8 Northeast Gale Signal	0	0
	No. 8 Southeast Gale Signal	0	0
	No. 8 Southwest Gale Signal	0	0
	No. 8 Northwest Gale Signal	1	7
	No. 9 Increasing Gale Signal	0	0
	All Signals Lowered	8	8
Strong Monsoon Warning (Black Ball)		11	30
Rainstorm Warning		10	32
Thunderstorm Warning		78	178
Storm Surge Warning		2	11

## Temperatures

Macao had an average annual temperature of 22.6°C during 2016, which was the same as the climate normal. The highest and the lowest average temperatures were 28.9°C in July and 13.9°C in February, respectively. The hottest day was 30 July, when the temperature rose to 36°C; whereas the coldest day was 24 January, when the temperature fell to just 1.6°C, setting a record low since 1948.

## Relative Humidity

The average relative humidity during 2016 was 85 percent, which was 6.2 percentage points higher

than the climate normal. April saw the highest monthly average relative humidity at 94 percent; whereas the lowest was 77 percent in February.

## Rainfall

Total rainfall during 2016 was 2,335.6 millimetres, which was 277.5 millimetres or about 13 percent more than climate normal. The highest monthly rainfall was recorded in August at 421.2 millimetres, 78.1 millimetres above normal. The lowest monthly rainfall was recorded in December, at 11.2 millimetres. The highest daily rainfall was recorded on 2 August at 155.6 millimetres.

## Evaporation

The total evaporation level in 2016 was 680.9 millimetres, which was 264.2 millimetres less than the climate normal. The evaporation levels in February and July 2016 were slightly higher than the climate normal, while the evaporation levels of other months in the year were all lower than the climate normal of the same period.

## Sunshine

During 2016, Macao had 1,529.5 hours of sunshine, 244.4 hours less than normal. The most hours of sunshine were recorded in July, totalling 243.5 hours, 20.3 hours above normal. The least hours of sunshine were recorded in April, amounting to only 16.7 hours, which was 68.6 hours less than normal.

## Wind

During 2016, Macao was subject to predominantly north-northeasterly winds in January, March, August, September, October and December, northerly winds in February and November, south-southeasterly winds from April to May, and southerly winds from June to July. Wind speeds averaged 10.6 kilometres per hour.

## Weather Services

### Meteorological and Geophysical Bureau

The Meteorological and Geophysical Bureau (SMG) is supervised by the Secretary for Transport and Public Works. It provides weather reports, monitors air quality, and conducts research into climate, climate change and earthquakes.

Apart from hourly real-time weather information, the SMG issues various types of daily weather forecasts for the public, government departments and private institutions. These include five weather reports and forecasts, two marine and weather forecasts for the Macao coastal area, as well as weather reports on the preceding day, which are broadcast daily for the public. The SMG provided 1,830 weather forecasts and 732 weather forecasts for the Macao coastal area during 2016.

Every day, SMG officers explain the day's weather conditions and the forecast for the following day in telephone reports broadcast on the Macau Broadcasting Company's (TDM) morning TV programme. The SMG launched the audio weather information service in 2015, in which forecasters regularly record weather information and upload it to the Internet for download and use by different media. This information includes a weather review of the day, a two-day weather forecast and air quality report; a weekly weather forecast; and special weather information (on typhoons, rainstorms, very hot and cold weather).

The SMG issues special weather information on its website in times of adverse weather conditions, including tropical cyclones, strong monsoons (black ball), rainstorms, thunderstorms and storm surges, so that the public are notified of the latest situation. When Typhoon Signal No. 3 or above is hoisted, the local broadcaster TDM will provide streaming updates on the latest developments concerning the tropical cyclone.

In response to special weather conditions (such as forecast of a substantial drop in temperature), the SMG sends special weather notifications to registered users, social welfare organisations and schools via WeChat and SMS.

Through the round-the-clock Automatic Air Quality Monitoring Network, the SMG announces real-time concentration of air pollutants and summarises daily air quality on its website every day. In addition, an air quality forecast for the following day is reported to the public.

The SMG Aeronautic Meteorological Center at Macau International Airport provides half-hourly weather observations and special reports to aviation organisations and flight crews.

The aeronautical meteorological documents include meteorological maps for every route, as well as upper wind and temperature charts, aviation weather reports and forecasts, and volcanic ash and tropical cyclone advisory information. The centre provided about 6,442 such documents to departing flights during the first quarter in 2016. To improve the quality and efficiency of the aeronautical meteorological services, a new online platform hosting aeronautical meteorological documents started operating in the second quarter of 2016. The platform's system typically operated at 100 percent efficiency through to the fourth quarter.

In recent years, the SMG has introduced the Mobile WebWeather Service, Macao page, on Weather China website; Macao SMG mobile application (APP) and the official WeChat account, "Macao SMG".

An SMS service and the 1311 Telephone Voice Response Weather Information Enquiry Service provide a wide array of weather information and air quality indices. In 2015, the SMG also began displaying up-to-date tropical cyclone and rainstorm warnings on the electronic monitors in the Border Gate checkpoint building and the Outer Harbour Ferry Terminal, in order to help border-crossing commuters to promptly respond to changes in weather.

In 2016, the SMG introduced the 48-hour Automatic Weather Forecast and Real-time Air Quality Index services, providing the public with temperature and humidity forecasts for the following two days and more timely air quality index on the website. In addition, the Weather Service Centre was established at the Outer Harbour Ferry Terminal, to provide travellers with the latest weather advice and information.

## Monitoring Network

The SMG collects weather data 24 hours a day via its Automatic Weather Station Network of 14 weather-observation stations in key locations around Macao. Three of these automatically send information every 15 minutes to destinations worldwide, using the international SYNOP code and the Global Telecommunications System (GTS). This forms part of the Pearl River Delta Real-time Automatic Weather Station Network, which was jointly established to exchange meteorological data by the Guangdong Provincial Meteorological Bureau, the Hong Kong Observatory and the Macao SMG.

The SMG also teamed up with the Hong Kong Observatory to establish a substation of the Pearl River Delta Lightning Location Network in Macao. The system operates around the clock, and provides real-time lightning information for the Pearl River Delta.

Regarding meteorological telemetry, the SMG has two ground meteorological reception and processing systems to receive Japanese Himawari-8 satellite information and Chinese FY-2E and FY-2G satellite information, respectively; two dual-polarisation Doppler weather radars; a low-level wind profiler; a microwave radiometer; a cloud height meter; three visibility measuring devices; and two lightning sensors to monitor lightning in the skies over Macao and the vicinity.

The SMG cooperated with related departments to establish the Water Level and Tide Monitoring Network, to provide round-the-clock real time data on flooding and tides in flooding black spots and coastal area. The network includes 17 land water level monitoring stations set up at flooding black spots in various districts of Macao, two tide monitoring stations set up along the coast, and one wave monitoring station in the sea.

**Air quality monitoring:** The SMG established the Air Quality Monitoring Project in partnership with Companhia de Electricidade de Macau (CEM). The SMG employs a fully automated air monitoring network to measure major pollutants that jeopardise Macao's air quality. Macao has five automatic air quality monitoring stations, a mobile air quality monitoring station and two mobile air monitors to monitor air quality of different districts in Macao. Moreover, in July 2012 the SMG adopted a new air quality standard, raising the air quality standard to WHO interim target-1(IT-1).

**Seismological monitoring:** The SMG has a seismological monitoring station in its Taipa Grande headquarters on Taipa, equipped with a digital seismograph and a deep shaft (30 metres from ground level) digital seismograph. In 2014, the deep shaft digital seismograph was upgraded and became a monitoring station of the Pearl River Delta Earthquake Early Warning Network. In addition, a seismic information sharing portal was introduced, to receive earthquake information for the entire country.

**Environmental radiation monitoring:** The SMG's headquarters is equipped with an environmental radiation monitoring station, mainly for detecting Gamma radiation dose rates in the atmosphere and announcing the results on the website. A baseline survey on Macao's atmospheric radiation began in 2013. Regular monitoring of Macao's atmospheric radiation is conducted every year in different districts.

## Regional and International Cooperation

The SMG is a member of the WMO. It actively participates in promoting technology, research,

training and applications relating to meteorology. Every year, it sends delegations to meetings, seminars, workshops and training programmes arranged by the WMO, mainland China and overseas meteorological agencies and academic organisations.

The SMG is also a member of the ESCAP/WMO Typhoon Committee. The committee secretariat moved to Macao in 2007.

The SMG also keenly takes part in meteorological science meetings and exchange activities conducted by its mainland China and overseas counterparts. In 2016, apart from the Guangdong-Hong Kong-Macao Seminar on Meteorological Science and Technology and the Guangdong - Hong Kong - Macao Meeting on Cooperation in Meteorological Operations organised alternately by the three parties, the SMG participated in the 16th Session of the WMO Commission for Basic Systems, the China-ASEAN Meteorological Forum, the 48th Session of ESCAP/WMO Typhoon Committee, the 22nd Conference of the Parties to the UNFCCC and the 12th meeting of the Parties to the Kyoto Protocol, and the 20th International Civil Aviation Organization Asia Pacific Air Navigation Planning and Implementation Regional Group Meeting.

## Air

Population density, scarcity of land, narrow streets and busy traffic all affect Macao's air quality. However, this is offset to some extent by the low discharge of industrial pollutants. The air quality is therefore generally quite good. Every winter, a comparatively high level of airborne pollutants raises the air pollution index; while in summer the air quality improves, with lower pollution index readings, as the convective precipitation of the tropical climate dispels pollutants.

During 2016, roadside monitoring stations recorded "good" air quality on 54.9 percent of days, "acceptable" air quality on 43.1 percent of days, and "poor" air quality on two percent (seven days). In the high-density residential area of the Macao peninsula, the air quality was "good" on 46.3 percent of days, "acceptable" on 48.5 percent of days, and "poor" air quality on 5.2 percent (19 days).

In the high-density residential area on Taipa, the air quality was "good" on 49.9 percent of days, "acceptable" on 45.3 percent of days, and "poor" on 4.7 percent of days (17 days). Ambient monitoring stations on Taipa recorded "good" air quality on 57.9 percent of days, "acceptable" air quality on 39.6 percent of days, and "poor" air quality on 2.5 percent of days (nine days). Ambient monitoring stations on Coloane recorded "good" air quality on 49.5 percent of days, "acceptable" air quality on 45.9 percent of days, and "poor" air quality on 4.6 percent of days (17 days).







In 2016, fine suspended particulates (PM<sub>2.5</sub>) and ozone (O<sub>3</sub>) led to "poor" air quality in Macao, with the former mainly affecting Macao in winter while the latter mainly affecting Macao in summer. The high-density residential area on Macao recorded "poor" air quality on 5.2 percent of days (19 days), the highest number of days among all monitoring stations. Overall, over 94 percent of days met the air quality standards ("good" to "acceptable") in 2016. Concentrations of respirable suspended particulates and fine suspended particulates showed a decreasing trend, while concentrations of other pollutants were largely equal to or less than those recorded in 2015.

### Average Pollutant Concentrations in 2016

Monitoring Station	Respirable suspended particulates ( $\mu\text{g}/\text{m}^3$ )	Fine suspended particulates ( $\mu\text{g}/\text{m}^3$ )	Sulphur dioxide ( $\mu\text{g}/\text{m}^3$ )	Nitrogen dioxide ( $\mu\text{g}/\text{m}^3$ )	Ozone ( $\mu\text{g}/\text{m}^3$ )	Carbon monoxide ( $\text{mg}/\text{m}^3$ )
Roadside	47.4	24.3	---	54.1	---	1.26
High-density residential area of Macao peninsula	41.6	25.9	7.6	45.9	47.9	0.80
High-density residential area of Taipa island	42.4	28.6	7.9	41.6	53.6	0.64
Taipa ambient	41.7	22.0	4.4	30.8	45.2	0.62
Coloane ambient	45.7	28.1	12.1	34.5	47.5	0.67

### Comparisons between Pollutant Concentrations and the Daily Air Pollution Index

Air quality index	Respirable suspended particulates 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Fine suspended particulates 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Sulphur dioxide 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Nitrogen dioxide 24-hour average ( $\mu\text{g}/\text{m}^3$ )	Ozone 8-hour average ( $\mu\text{g}/\text{m}^3$ )	Carbon monoxide 8-hour average ( $\text{mg}/\text{m}^3$ )
0	0	0	0	0	0	0
50	100	35	40	100	80	5
100	150	75	125	200	160	10
200	350	150	660	750	350	17
300	420	250	1,300	1,500	600	34
400	500	350	1,700	2,000	800	46
500	600	500	2,120	2,500	1,000	57

Air Pollution Index						
Air quality index	0 ~ 50	51 ~ 100	101 ~ 200	201 ~ 300	301 ~ 400	401 ~ 500
Air quality level (Macao standards)	Good	Acceptable	Poor	Bad	Severe	Harmful
Symbol						

## Noise

There are many reasons for noise pollution in Macao. Urban characteristics, such as population density, busy traffic, narrow streets and the large number of high-rise buildings, create conditions for noise transmission.

In 2016, the Environmental Protection Bureau and the Public Security Police received 8,291 complaints about ambient noise, two cases or about 0.02 percent more than the 2015 figure. The Environmental Protection Bureau received 1,087 of these complaints, representing a decrease of 213 cases or 16.4 percent compared with 2015; whereas the Public Security Police received the remaining 7,204 cases, a figure that was 215 cases or 3.1 percent more than that of 2015.

Complaints received by the Environmental Protection Bureau and the Public Security Police were primarily related to “Activities of daily life and pets in residential buildings” (31.3 percent or 2,593 cases), public areas (31.2 percent or 2,588 cases), and industry, commerce and services (13.6 percent or 1,129 cases).

## Environmental Noise Monitoring Network

In 2016, Macao had six environmental noise monitoring stations – three on the Macao peninsula, one on Taipa island, one in the COTAI Reclamation Area and one in Coloane. They conduct round-the-clock monitoring of ambient noise; road traffic noise; and noise from the mixed industrial, commercial and residential zones, by means of an automated network. Data on such noise readings are published monthly in the Environmental Geographic Information System on the Environmental Protection Bureau’s website.

## Water Quality and Wastewater Treatment

### Water Quality

Situated at the mouth of the Pearl River, Macao occupies a peninsula and nearby islands facing Lingdingyang to the east and the South China Sea to the south; there is a wide expanse of water.

Water exchanges resulting from tidal flows dilute pollutants entering the area. The Inner Harbour to the west of Macao is a favourite berthing place for Zhuhai and Macao fishing boats. The sluice of the Zhuhai Qianshan River lies upstream of the Inner Harbour channel, and when this is closed the area is partially blocked off. The poor exchange of its waters with the sea results in conditions in which pollutants can accumulate. When the sluice is open, Macao's water quality is determined by the quality of the water in the Qianshan River. Pollutants that have accumulated will then flow to neighbouring waters.

Based on the geographic features of Macao, the Public Health Laboratory of the Health Bureau adopts Category 3 Water Quality Standard of the Sea Water Quality Standard of China (GB3097-97), to assess individual indicators, nutrition indicators and comprehensive indicators of the water quality at each monitoring station.

## **The Monitoring and Assessment Report of Water Quality in Macao Waters 2015**

### **Water Quality Monitoring Network**

Currently, three automatic water quality monitoring stations are under the management of the Environmental Protection Bureau at Ilha Verde Dockyard and Cotai Nature Reserves. Round-the-clock monitoring of water quality is conducted through an automated network. Data on the water quality readings are published monthly in the Environmental Geographic Information System on the Environmental Protection Bureau's website.

### **Monitoring Drinking Water Quality**

The Civic and Municipal Affairs Bureau Laboratory is responsible for the public water supply network; inspecting the water quality of public and private water sources and wells; and – if necessary – recommending the closure of these facilities in the public interest. It regularly monitors the quality of water processed by the Macao Water Supply Company, and other water supply networks and reservoirs in the territory, to verify whether the quality complies with the requirements stipulated in the Rules and Regulations on Water Supply and Drainage in Macao (Decree-Law No. 46/96/M).

Since being awarded the ISO/IEC 17025 Certificate of Laboratory Accreditation by the China National Accreditation Committee for Laboratories (CNAL) (now China National Accreditation Service for Conformity Assessment) in 2003, the laboratory has enhanced its analytical performance and its quality management system. The laboratory also continued to participate in proficiency tests held by renowned organisations in mainland China and countries including the United States, the United Kingdom and Australia. The laboratory's inspection technology has fulfilled international requirements. Currently, it possesses 300 accreditation parameters.

### **Wastewater Management**

The five sewage treatment facilities in Macao – the Macao Peninsula Sewage Treatment Plant,

Crossborder Industrial Zone Sewage Treatment Plant, Taipa Sewage Treatment Plant, Macau International Airport Sewage Treatment Plant and Coloane Sewage Treatment Plant – can handle 356,000 cubic metres of sewage per day.

In 2016, the Macao Peninsula Sewage Treatment Plant handled 59,007,624 cubic metres of sewage; Taipa Sewage Treatment Plant handled 8,746,641 cubic metres; Coloane Sewage Treatment Plant handled 15,820,989 cubic metres; the sewage treatment plant at Macau International Airport processed 60,320 cubic metres; and the Crossborder Industrial Zone Sewage Treatment Plant handled 415,117 cubic metres.

In 2016, the open tenders for the operation and maintenance services for the Macao Peninsula Sewage Treatment Plant and Cross-border Industrial Zone Sewage Treatment Plant were completed. The formulation of the Macao Sewage Treatment Facilities Master Plan also commenced at the end of the year, to assess the changes in the amounts of sewage through field reviews of the sewage treatment facilities, in order to formulate the short-, mid- and long-term development plan for sewage treatment. Reflecting its commitment to the policy of environmental protection, the Environmental Protection Bureau will continue to improve its equipment for handling and treating sewage, upgrade equipment in current sewage treatment plants, gradually increase the capability to treat domestic sewage in Macao, and enhance the quality of treated effluent.

## Waste Management

Companhia de Sistemas de Resíduos, Lda. (CSR) has been contracted to undertake Macao's waste collection and conveyance, urban cleaning operations and the cleaning and maintenance of public waste containers, under the Government's supervision. The CSR collected about 284,290 tonnes of waste in Macao during 2016, an average of about 777 tonnes a day.

## Waste Classification

The Civic and Municipal Affairs Bureau continued to optimise public sorting and recycling facilities in the community. The number of public collection points in Macao was increased to 341. The bureau also invited schools, government departments, associations, private organisations and buildings to participate in the reusable waste sorting and recycling programme, aiming to provide the public with convenient ways to recycle waste. During 2016, 2,706.4 tonnes of waste paper, 188.4 tonnes of metals and 183.3 tonnes of plastic were recycled through various reusable waste sorting and recycling programmes.

The Civic and Municipal Affairs Bureau continued its glass bottle recycling programme. Participants include hotels, schools, bars and karaoke parlours. The number of public collection points for glass bottles in Macao increased to 70. A total of 660 tonnes of waste glass were recycled during 2016. To reduce the volume of organic waste, a wet market food waste recycling programme, a school food waste recycling programme and a community food waste recycling (pilot) programme were launched; they processed a total of 101 tonnes of food waste during the year. Also, a programme for reusing clothes was jointly launched with the Macau Salvation Army, to improve the system for reusing clothes in Macao; about 400 tonnes of used clothes were collected during the year.

## **Macao Waste Incineration Centre**

Macao Incineration Centre is responsible for processing all Macao's household waste, together with some solid waste collected from the sea by the Marine and Water Bureau. It comprises two plants, with a total processing capacity of 1,728 tonnes of waste per day. During 2016, the centre processed 517,279 tonnes of municipal solid waste, an average of 1,413 tonnes a day.

The waste heat produced by the round-the-clock incineration centre during the treatment of the municipal solid waste can be recovered and used for power generation. The power generated by the centre can supply up to 21MW per hour of electricity at full load to the public grid – sufficient to meet the needs of over 33,000 households in Macao. During 2016, the incineration centre supplied 16,146 units (16,146kWh) of electricity to the public grid.

In 2016, the research on the feasibility of expanding and upgrading the Macao Central Incineration Centre was continued. Food waste recycling was also promoted. The first on-site food waste treatment project in the public housing was established in Seac Pai Van. Food waste processors with a daily treatment capacity of 1,000 kilograms were also added to the centre, in order to collect more food waste. Food waste recycling was implemented in the Food Festival held in 2016.

## **Macao Special and Hazardous Waste Treatment Centre**

The Macao Special and Hazardous Waste Treatment Centre, adjacent to the Taipa Incineration Centre, commenced operation in 2007. It handles special waste according to the latest European Union incineration standard, including medical waste, slaughterhouse waste, discarded tyres, carcasses of animals such as horses and dogs, oil residue, and other solid and liquid special wastes. In 2016, the waste treatment centre's total treatment capacity (including medical waste) was 1,845 tonnes, with discarded tyres comprising 21 percent of the treatment capacity.

To make used battery collection more convenient for residents, used battery collection points were set up at 50 public refuse tips.

## **Treatment of Construction Waste**

The construction waste landfill site is located on Avenida do Aeroporto in Taipa. Since it commenced operations in March 2006, it has been mainly used for the disposal of non-combustible inert solid waste produced through excavation, demolition, and construction. The solid waste includes debris, cement blocks, soft soil and marine clay.

## **Automatic Solid Waste Collection System**

The pilot scheme for automatic solid waste collection in the Areia Preta New Reclamation Zone (NATAP) was established in 2006. The system comprises a number of inlet valves connecting with a network of underground tubes. The waste is transported by means of air suction to a transfer station between Ponte da Amizade Avenue and Macao Wastewater Treatment Plant, from where it is taken by trucks to the incineration centre.

## **Legislation and Pollution Control**

The Environmental Law (Law No. 2/91/M) gazetted on 11 March 1991 sets guidelines and basic principles for the protection of Macao's environment. Subsequent subsidiary legislation covering other environmental issues includes:

- Formulation of Measures to Control and Minimise the Use of Substances Destructive to the Ozone Layer (Decree-Law No. 62/95/M, 4 December 1995);
- Rules and Regulations on Water Supply and Drainage in Macao (Decree-Law No. 46/96/M, 19 August 1996);
- Regulations on Prohibition Against Dropping and Discharging Harmful Substances in Marine Jurisdictions (Decree-Law No. 35/97/M, 25 August 1997);
- Identification of Features of and Formulation of Requirements on Unleaded Petrol, Provisions on the Import and Registration of Vehicles Consuming Unleaded Petrol starting from 1 January 1995 (Decree-Law No. 44/94/M, 22 August 1994);
- Provisions on the Sulphur Content of Vehicular Light Diesel Fuel (Executive Order No. 4/2006);
- Emission Limits of Exhaust Pollutants by Newly Imported Heavy and Light Motorcycles (By-law No. 1/2008);
- Approval of the Table of Parameters of Emissions of Exhaust Pollutants for Vehicles with Four-stroke Engines to Supersede Schedule 1 and 2 of Annex 1 of Executive Order No.1/2008 (Executive Order No. 356/2010);
- Regulations on Tailpipe Emissions of New Imported Vehicles (By-law No. 1/2012);
- Amendment to Regulations on Motor Vehicle Tax (Law No. 1/2012);
- Environmental Emission Standard for New Light Vehicles (Executive Order No. 41/2012);
- Air Pollutant Emission Standard and Facility Management Regulations for Cement Manufacturing Premises (Executive Order No. 12/2014);
- Prevention and Control of Environmental Noise (Law No. 8/2014) and Standard for Acoustics approved by Executive Order No. 248/2014, to supersede Regulations on Prevention and Control of Environmental Noise (Decree-Law No. 248/2014, 14 November 1994) and Standard for Acoustics (Decree-Law No. 241/94/M), respectively; and
- Tightening the New Emissions Standards for Light Vehicles (Executive Order No. 59/2015).

These laws have been enacted to reduce and control pollution in waste treatment, water, fuel, noise, the atmosphere and light, and to achieve the objective of environmental protection.

In 2016, the Rules Concerning Unleaded Petrol and Light Diesel for Vehicles (By-law No. 15/2016), to replace Decree-Law No. 44/94/M (promulgated on 22 August, Executive Order No. 4/2006, and the Limit for Exhaust Gas Emissions from In-use Vehicles and Methods of Measurement (By-law No. 30/2016), were promulgated. Import and transshipment to the MSAR of hazardous

wastes listed in Annex 1 of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal are prohibited with Executive Order No. 410/2016.

The Government has also established the Environmental Protection and Energy Conservation Fund with By-law No. 21/2011, and established the Environmental Protection, Energy-saving Products and Equipment Subsidy Scheme with By-law No. 22/2011.

## International treaties

Several international agreements and treaties to address global environmental problems have been made applicable to Macao. These include:

- Vienna Convention for the Protection of the Ozone Layer;
- Montreal Protocol on Substances that Deplete the Ozone Layer;
- Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer;
- London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer;
- Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer;
- Montreal Amendment to Montreal Protocol on Substances that Deplete the Ozone Layer;
- Beijing Amendment to Montreal Protocol on Substances that Deplete the Ozone Layer;
- United Nations Framework Convention on Climate Change;
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES);
- Convention on Biological Diversity;
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal and the amendment to the Basel Convention adopted by Decision III/1 in the Third Conference of the Contracting Parties in Geneva on 22 September 1995;
- Plant Protection Agreement for the Asia and Pacific Region (with amendments made in 1967, 1979 and 1983);
- Stockholm Convention on Persistent Organic Pollutants (POPs) and its amendments passed on 8 May 2009 and 29 April 2011;
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade;
- Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques;
- International Plant Protection Convention;
- Protocol on Environmental Protection to the Antarctic Treaty; and
- Kyoto Protocol to the United Nations Framework Convention on Climate Change.

International treaties on maritime safety related to marine environment protection applicable to Macao include:

- International Convention on Oil Pollution Preparedness, Response and Co-operation 1990;
- Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships 1973 (MARPOL);
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972) and its 1978 and 1980 amendments;
- International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001; and
- Convention on the Conservation of Antarctic Marine Living Resources.

### **Environmental Protection Bureau**

The Environmental Protection Bureau (DSPA) is charged with studying, planning, executing, coordinating and promoting environment policies.

### **Environmental Protection and Energy Conservation Fund**

The Government established the Environmental Protection and Energy Conservation Fund through By-law No. 21/2011, and established the Environmental Protection, Energy-saving Products and Equipment Subsidy Scheme through By-law No. 22/2011, to subsidise enterprises and community groups in Macao to increase their capability for protecting the environment; and to introduce environmental protection techniques and devices, in order to further enhance environmental protection work and development of the environmental protection industry.

The Environmental Protection, Energy-saving Products and Equipment Subsidy Scheme was the first subsidy scheme since the establishment of the Environmental Protection and Energy Conservation Fund. It targets commercial enterprises and community organisations. According to Order No. 63/2014 of the Secretary for Transport and Public Works, the application deadline for the Environmental Protection, Energy-saving Products and Equipment Subsidy Scheme is extended to 31 December 2015. As of 2015, the Environmental Protection Bureau had received over 7,600 applications for subsidies; 5,800 applications were handled in 2016, of which over 4,700 were approved, involving subsidies of more than 390 million patacas.

### **Promotion of Environmental Protection Education**

With the theme “Building a Low Carbon Macao and Embracing a Green Life”, the Environmental Protection Bureau organised various promotional and educational activities for all levels of society to boost public awareness of environmental protection and to encourage the public to put environmental protection into practice.

In 2016, the Environmental Protection Bureau organised 237 events, with a total of 158,179 participants.

The Environmental Protection Bureau has formulated proposals on eco-friendly product specifications for 80 common products. Together with the Eco-friendly Merchandising Guidelines for Public Departments, they provide references for eco-friendly merchandising in different sectors. In 2016, the Environmental Protection Bureau organised three training programmes on eco-friendly merchandising for public departments.

Since 2012, the Environmental Protection Bureau has cooperated with the Pension Fund to promote the Civil Service Provident Fund System - Electronic Account Document Service, to reduce the use of paper, save costs and increase administrative efficiency. As of the fourth quarter of 2016, more than 9,000 contributors to the provident fund system participated in this programme, saving a total of 322,787 pieces of environmentally-friendly A4 paper, 125,598 pieces of A3 matte paper, and 125,346 envelopes.

As of 2016, 36 hotels had received the Macao Green Hotel Award, accounting for about one third of hotels in Macao, involving over 18,000 guest rooms, which are around a half of the total number of hotel guest rooms in Macao. In 2016, “Basic Certificate” was introduced and presented to budget hotels that implemented basic environmentally-friendly measures, to encourage them to pay attention to and promote environmental protection work, and gradually improve their performance in environmental protection. The hotels receiving awarded made progress in energy, water and waste (including food waste) reduction, facilitating the hotel industry’s reduction of operating costs, as well as contributing to reducing consumption of resources and improving the environment.

To encourage residents to use fewer plastic bags in daily life, the Environmental Protection Bureau launched the “Use fewer plastic bags” campaign in 2013. This has been held for four consecutive years, involving public departments, social groups and businesses. “Use fewer plastic bags 2016” was held between 1 June and 31 August. The number of participating stores greatly increased, by 65 percent to over 210. During these four years, the campaign received support from the participating stores and the public. More than 150,000 people participated in this campaign, indicating that at least 150,000 plastic bags were saved.

In February 2016, the Environmental Protection Bureau completed the public consultation on the implementation of a system to restrict the use of plastic shopping bags, and announced a summary report with compiled comments in August 2016. The Environmental Protection Bureau will improve a practical solution for the “plastic bag levy” measure, with the aim of defining by law the responsibilities of business owners, consumers and the government in reducing undue use of plastic bags.

In 2016, the Environmental Protection Bureau continued to roll out the Green School Project, which involved organising various environmental education events, and with more than 18,000 teachers and students from 72 schools participating. The bureau also conducted 38 training sessions on Management Guidelines for Green School Environment in Macao, which attracted participation by 2,000 school leaders and teaching staff.

The Environmental Protection Bureau continued implementing the Environmental Protection Fun Bonus Point Scheme. By the end of December 2016, there were more than 7,800 members in the first phase of Environmental Protection Fun – waste reduction and recycling. The second phase of the scheme – environmentally-friendly moves – encouraged people from all walks of life to join the scheme’s frontline team (Environmental Protection Fans). They assisted in providing a

guided tour service in Cotai Nature Reserve, to leverage the synergy between teaching and learning. In addition, they promoted environmental messages to the public during environmental festivals such as Wetland Day, Earth Day and World Environment Day, and traditional festivals such as Lunar New Year, Mid-Autumn Festival and Christmas, and encouraged the public to participate in environmental activities and put environmental protection into practice.

## **Regional Cooperation on Environmental Protection**

The 2016 Macao International Environmental Co-operation Forum (2016 MIECF) was held from 31 March to 2 April. The theme was Green Economy – Opportunities for Waste Management, which advocated “Thinking Green, Going Clean, Living Cool”.

A total of 32 contracts were signed during the three-day forum, reflecting the MIECF’s role as a green platform that successfully promotes development of the environmental protection industry and technologies. The MIECF set “waste management” as the theme of the forum, given enterprises’ growing concern regarding ways to treat waste without harming the environment. Six forums and one special session were organised, involving 46 experts from 11 countries and regions.

In 2016, the Ministry of Science and Technology of the PRC and the Environmental Protection Bureau completed the Typical Electronic Waste Processing Equipment and Follow-up Treatment project.

Regarding the PPRD region, the Environmental Protection Bureau participated in the 12th Coordinator Working Meeting of the Joint Conference on Pan-Pearl River Delta Regional Environmental Protection Cooperation, the 19th China International Fair for Investment and Trade, the PPRD Environmental Technology Exchange and the Motor Vehicle/Vessel Emission Control Workshop 2016.

The Guangdong-Hong Kong-Macao Air Quality Monitoring Network for the Pearl River Delta Region Data Management and Publishing Platform Cooperation Agreement, signed by Guangdong, Hong Kong and Macao, came into effect on 1 April 2016. Guangdong, Hong Kong and Macao will continue with the management and maintenance of the Guangdong-Hong Kong-Macao PRD Regional Air Quality Monitoring Network.

Under the Framework Agreement on Cooperation Between Guangdong and Macao in Environmental Protection, in 2016 Guangdong and Macao continued with the recycling and disposal of scrap vehicles and inert construction and demolition materials. In May 2016, the Guangdong-Macao Environmental Cooperation Task Force Meeting was held, to enhance cooperation regarding environmental protection during the dredging of Canal dos Patos and treatment of solid waste.

Hong Kong and Macao also cooperated in environmental protection. In July 2016, the two sides attended the Eighth Meeting on Environmental Protection Cooperation between Hong Kong and Macao, for summarising past cooperation and communication on various aspects of the environment, and exchanging views on the standard and regulatory system concerning emissions by the Macao catering industry, and Hong Kong’s Restored Landfill Revitalisation Funding Scheme. The Hong Kong-Macao environmental protection cooperation plan for the coming year was also formulated.

In October 2016, the Environmental Protection Bureau organised a delegation to attend the

Eco Expo Asia 2016 in Hong Kong, as well as the Eco Asia Conference that was held during the same period. The Hong Kong - Macao Environmental Protection Co-operation Agreement was signed by the Environmental Protection Bureau and the Environmental Protection Department of the Hong Kong Special Administrative Region, further enhancing cooperation between the two sides, to facilitate sustainable development of the regions and jointly improve the environment.

Under the framework of the Zhuhai-Macao Environmental Protection Cooperation Agreement, the Zhuhai-Macao Environmental Cooperation Working Group Meeting 2016 was held on 28 April 2016, to exchange views on cooperation on various areas. In addition, the Environmental Protection Bureau organised a delegation of 30 representatives from 18 green schools in Macao, to visit green schools and nature reserves in Zhuhai, and exchange views on school environmental education and campus environmental protection facility management. The bureau also sent delegates to attend a meeting on cooperation in black-faced spoonbill protection and the Symposium on Zhuhai-Macao Wetland Ecological Conservation in March and November 2016, respectively.

## Environmental Protection Planning in Macao

In late 2016, the Environmental Protection Bureau announced the Interim Implementation and Effectiveness Assessment of the Environmental Protection Plan of Macao (2010-2020). This assesses the implementation of the action plan, green indicators, environmental function zoning, environmental standards and progress with research projects concerning legislation related to the interim plan (2013-2015) for the Macao Environmental Protection Plan (2010-2020).

## Examination of Environmental Data

To strictly adhere to the regulations in Executive Order No. 4/2006, the Environmental Protection Bureau continued to monitor the sulphur content of vehicular light diesel fuel available for sale in Macao. To this end, the bureau took samples of vehicular light diesel for analyses and testing from fuel pumping stations in Macao, Taipa and Coloane, and the Ka Ho Fuel Oil Terminal, in February and May 2016. The results indicated that the sulphur content in all samples was below the maximum permitted level of 0.005 percent, as specified in Executive Order No. 4/2006.

The MSAR promulgated the “Rules concerning unleaded petroleum and light diesel for vehicles” (By-law No. 15/2016) on 13 June 2016, to improve the quality of Macao’s vehicular unleaded petroleum and light diesel, in order to meet the Euro V vehicle emission standards, which are more environmentally efficient. The Transport Bureau is responsible for monitoring compliance with this by-law.

Complaints received by Environmental Protection Bureau in 2016:

Category	Number of cases
Noise	980
Air pollution	388

(Cont.)

Category	Number of cases
Noise and air	79
Noise and other	28
Air and other	22
Environmental hygiene	29
Other	59
<b>Total</b>	<b>1,585</b>

Technical advice provided at the request of other departments in 2016:

Departments	Premises and projects	No.
Tourist Office	Premises including karaoke, bar, hotel, restaurant, sauna and massage establishments, dance hall and health club, etc.	259
	Inspection before issuance or renewal of licences	90
Economic Services Bureau	Technical advice	0
	Inspection in industrial sites	7
Lands, Public Works and Transport Bureau	Pile foundation (environmental protection) project and application for extension of construction time	111
Civic and Municipal Affairs Bureau	Technical advice on licensed premises	223
	Site inspection	169
	Technical advice on applications for import of HCFCs defined as controlled substances under Decree-Law No. 62/95/M	13

## Flora

Macao abounds in plant species. By 2004, researchers from the Civic and Municipal Affairs Bureau and the South China Institute of Botany under the Chinese Academy of Sciences had identified 1,508 species of flora in Macao. These are mainly found in woodlands, parks and leisure grounds. Most

of Macao's vegetation belongs to the evergreen broad-leaf woodland, tree, shrub and coastal bush groups, including such species as Rose Myrtle (*Rhodomyrtus tomentosa*), Blood-red Melastoma (*Melastoma sanguineum*), Oblong leaved Litsea (*Litsea rotundifolia* var. *oblongifolia*), Pop-gun Seed (*Bridelia tomentosa*), Hong Kong Hawthorn (*Rhaphiolepis indica*) and Linear Forked Fern (*Dicranopteris pedata*). The most common species of cultivated plants are the Chinese Hibiscus (*Hibiscus rosa-sinensis*), Hong Kong Orchid Tree (*Bauhinia blakeana*), Sunshine Tree (*Cassia surattensis*) and False Groundnut (*Desmodium heterocarpon*). Also, according to research conducted until 2010 by the Civic and Municipal Affairs Bureau and researchers from the Shenzhen FairyLake Botanical Garden, Macao has 104 species of bryophytes which belong to 34 genera and 63 families. Rare species include *Fissidens macaoensis*, *Kurzia sinensis*, *Phaeoceroa laevis*, *Notothylas japonica* horik, *Micromitrium* and *Vesicularia*. *Fissidens macaoensis* is a new species to science. As it was discovered in Macao, its Latin name includes "Macao".

The terrestrial vegetation in Macao has a relatively diverse plant community. Five types of vegetation can be identified: coniferous forests, mixed conifer-broadleaf forests, evergreen broadleaf forests, mixed deciduous and evergreen broadleaf forests and shrubs. There are 30 formations and 59 associations under these vegetation types.

A total of 4,045,300 square metres of forest areas were replanted on Taipa and Coloane islands between 1982 and 1995. More than 55 tree species were introduced during the process. Of the 26 major tree species in Macao, Taiwan Acacia (*Acacia confusa*) accounts for the lion's share, with more than 60 percent. It is followed by Chinese Guger tree (*Schima superba*), *Schima wallichii*, Sweet Gum (*Liquidambar formosana*), Big-leaved Acacia (*Acacia mangium*), Sunshine Tree, White Bauhinia (*Bauhinia variegata* var. *candida*), Camel's Foot Tree (*Bauhinia variegata*), Lebeck Tree (*Albizia lebeck*) and Horsetail Tree (*Casuarina equisetifolia*) are also major species. From the end of 2000, forest areas on Taipa and Coloane have undergone a compositional transformation. A firebreak was set up, and many indigenous tree species were introduced, including Melia-leaved Evodia (*Tetradium glabrifolium*), Hong Kong Gordonia (*Gordonia axillaris*), Acronychia (*Acronychia pedunculata*), Morris's Persimmon (*Diospyros morrisiana*), India Carallia (*Carallia brachiata*), Yanmin (*Dracontomelon duperreanum*), Persimmon-leaved Litsea (*Litsea monopetala*), *Michelia chapensis*, Burmese Rosewood (*Pterocarpus indicus*), Heterophyllous Winged-seed Tree (*Pterospermum heterophyllum*), Silver-back Artocarpus (*Artocarpus hypargyreus*), *Pinus elliottii* × *Pinus oaribaea*, Common Fig (*Ficus carica*), Horse-tail Pine (*Casuarina equisetifolia*), Chinese Holly (*Ilex rotunda*), *Michelia macclurei* and Chinese Guger Tree (*Schima superba*).

In addition to the commonly used leafy plants in the past – namely the Dwarf Yellow (*Duranta repens*), Golden Leaves (*Ficus microcarpa*), Golden Dewdrops (*Duranta repens* 'variegata'), Purple Knight (*Alternanthera dentata*), *Fagraea ceilanica* and Painted Copper Leaf (*Acalypha wilkesiana*) – colours were added to the green belts to improve greening of streets in Macao and create a better view by growing colourful flowering shrubs, such as Indian Azalea (*Rhododendron simsii*), *Cordyline fruticosa*, Small Allamanda, *Lantana montevidensis* and *Ruellia brittoniana* in recent years. The view looks more layered with the addition of these flowers, accompanied by other trees such as Golden Trumpet Trees, *Terminalia mantaly*, Camel's Foot Tree (*Bauhinia variegata*) and Chinese Banyan (*Ficus microcarpa*).

## Fauna

Macao is small. The development of land and expansion of urbanisation affect and damage the survival and scope of activities of wild animals. The numbers of species and populations of wild animals in Macao are decreasing.

The scarcity of unpolluted waters in Macao leads to a decrease in the diversity and numbers of amphibians. The five commonest species are Asian Common Toad (*Bufo melanostictus*), Gunther's Frog (*Rana guentheri*), Brown Tree Frog (*Rhacophorus megacephalus*), Paddy Frog (*Fejervarya limnocharis*) and Asian Painted Frog (*Kaloula pulchra*). In the hilly forest area of Coloane, the Civic and Municipal Affairs Bureau has constructed artificial freshwater wetlands as better habitats for amphibians.

The commonest wild mammals are bats, rats and Red-bellied Tree Squirrels. Bats mainly inhabit Coloane and Taipa. In 2013, Chinese Rufous Horseshoe Bat (*Rhinolophus sinicus*) was newly recorded. The Japanese House Bat (*Pipistrellus abramus*) and Short-nosed Indian Fruit Bat (*Cynopterus sphinx*) can be found on the Macao peninsula. The former frequents gaps between buildings and lives on mosquitoes and flies, helping to limit populations of harmful insects. The latter eat fruits in parks or woods, and may help spread their seeds, contributing to the city environment and natural environment of the woods. The Red-bellied Tree Squirrel is an exotic species, formerly imported as a pet. It is now wild in Macao. Its lack of natural enemies poses a threat to other animal species, especially birds, as the squirrels eat their eggs.

Reptiles, especially snakes, play an important ecological role in controlling the number of rats. Large-spotted Cat Snake (*Boiga multimaculata*) and Many-banded krait (*Bungarus multicinctus*), which are relatively rare, were recorded in Coloane in 2013. However, Macao's dense population poses an enormous threat to their dwelling and foraging areas. In addition, some people's misunderstanding and fear about snakebites have caused the number of snakes to decrease most significantly among all wild animals in Macao.

Previous studies recorded over 300 species of birds in Macao. Dominant species were Chinese bulbul (*Pycnonotus sinensis*, terrestrial) and Little Egret (*Egretta garzetta*, waterbirds). There were nine common species, of which terrestrial birds outnumbered waterbirds. Among these, five common species were terrestrial birds – Japanese White-eye (*Zosterops japonicus*), Crested Myna (*Acridotheres cristatellus*), Common Tailorbird (*Orthotomus sutorius*), Eurasian Tree Sparrow (*Passer montanus*) and Chinese Hwamei (*Garrulax canorus*); and four were waterbirds: Kentish Plover (*Charadrius alexandrinus*), Black-crowned Night Heron (*Nycticorax nycticorax*), Grey Heron (*Ardea cinerea*), and Chinese Pond Heron (*Ardeola bacchus*). Species newly recorded in 2013 were: Fujian Niltava (*Niltava davidi*), Black-faced Bunting (*Emberiza spodocephala*), Eastern Water Rail (*Rallus indicus*), Saunders's Gull (*Chroicocephalus saundersi*), Common Snipe (*Gallinago gallinago*), Ruddy Turnstone (*Arenaria interpres*), Savanna Nightjar (*Caprimulgus affinis*), Ashy Minivet (*Pericrocotus divaricatus*), Chinese Grosbeak (*Eophona migratoria*) and Chinese Blue Flycatcher (*Cyornis glaucicomans*). Since 2006, over 216 species of birds from 14 orders and 50 families have been recorded.

There are abundant fish stocks in Macao, which can be categorised into saltwater fish, brackish fish and freshwater fish. Saltwater fish and brackish water fish mainly refer to the fish off the coast

of Macao. There are approximately 200 species of these fish. Freshwater fish most need protection in the natural environment. Although the habitats of freshwater fish and amphibians are similar to each other, the former have a narrower sphere of activities. Whenever the environment is destroyed or altered by human activities, they are often affected most directly.

There are over 500 species of insects, which are widely distributed in Macao, including 78 butterfly species.

## Laws Governing Nature Conservation

Macao began to enact laws and regulations on nature conservation – including the establishment of nature reserves and the protection of flora and fauna of special interest – more than 20 years ago. New by-laws were promulgated in 2004 to replace older ones. They are as follows:

1. Decree-Law No. 33/81/M, gazetted on 19 September 1981; Decree-Law No. 30/84/M, amended on 28 April 1984; and Decree-Law No. 3/99/M, revised on 25 January 1999, which designated a 196,225-square-metre area of Seac Pai Van Country Park as a conservation area of outstanding educational, ecological, scenic and scientific value;
2. Decree-Law No. 56/84/M, gazetted on 30 June 1984, and Decree-Law No. 83/92/M, amended on 31 December 1992, which designated the part of Coloane island with an altitude of over 80 metres as a conservation area;
3. The Environmental Law, approved by the Legislative Assembly on 6 November 1990 and gazetted by Decree-Law No. 2/91/M on 11 March 1991, which set out general guidelines and basic principles for the formulation of environmental policies;
4. General Regulations Governing Public Places (By-law No. 28/2004) enacted on 28 July 2004, which established general principles for behaviour to be observed when using and enjoying public places; and
5. By-law No. 40/2004 on Sanitary and Phytosanitary Control enacted on 14 December 2004, which defined the Civic and Municipal Affairs Bureau's role in the sanitary and phytosanitary control of merchandise.

Also, the Animal Protection Law (Law No. 4/2016) came into effect on 1 September 2016, with regulations on keeping, managing and selling animals, and the use of animals in public exhibitions and scientific applications.

In addition, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Biological Diversity, and the International Plant Protection Convention have been made applicable to Macao, thus ensuring that Macao's nature conservation policies conform to international practices.

## Nature Reserve

The Taipa-Coloane Wetland Reserve managed by the Environmental Protection Bureau is situated adjacent to the Lotus Flower Bridge in Taipa and Coloane. It has a total area of 55 hectares, including

a 40-hectare bird foraging area that is regarded as zone two of the reserve, on the west coast of reclaimed area between Taipa and Coloane. Next to this zone is a 15-hectare bird habitat, regarded as zone one of the reserve, which provides different bird species (including the rare Black-faced Spoonbill) with suitable habitats.

As at the end of December 2016, the Cotai Nature Reserve's known biodiversity included 163 planktonic algae, 366 land plants (*embryophyte*), 102 plankton, 89 zoobenthos, 387 insects, 69 fishes, five amphibians, 20 reptiles and 10 mammals. This diversity attracted 171 species of birds to the nature reserve, including the Black-faced Spoonbill (*Platalea minor*).

## Country Parks

There are four country parks in Macao: Seac Pai Van Country Park, Taipa Grande Nature Park, Hac Sa Reservoir Country Park, and Ka Ho Reservoir Country Park.

### Seac Pai Van Country Park

Adjacent to Seac Pai Van Road in western Alto de Coloane, Seac Pai Van Country Park covers an area of about 198,000 square metres, and provides a wide range of facilities. Its animal facilities comprise the Giant Panda Pavilion, a zoo, and an aviary. Its exhibitions facilities feature the Giant Panda Information Centre and the Museum of Nature and Agriculture. Other leisure facilities include a children's playground, a large picnic area and a snack bar.

### Giant Panda Pavilion

Set against a hill side in Seac Pai Van Park of Coloane, with a fan-shaped layout and an area of about 3,000 square metres, Macao Giant Panda Pavilion is designed to combine the terrain's natural undulations with the architectural characteristics. The pavilion comprises two 330-square metre indoor activity quarters and a 600-square metre outdoor yard. The appearance of the Macao Giant Panda Pavilion is designed to mimic nature, and it features green elements with leisure facilities such as pools and wooden climbing frames for the pandas.

### Taipa Grande Nature Park

Taipa Grande Nature Park is on the east of Taipa island, and covers a wooded and hilly area of 13,000 square metres between Ponta da Cabrita Road, Governador Nobre de Carvalho Avenue and Padre Estevao Eusebio Situ Road. The park houses a native fish breeding zone, 56 sculptures representing the 56 Chinese ethnicities, Taipa Grande exhibition hall, barbecue area, grass skiing slope, children's playground and a memorial pavilion for Mr. Henry Fok. It is a multifunctional park for relaxation, exercise, environmental protection, education and retreat. It is also an ideal destination for Macao residents to enjoy forest scenery to the full, embrace nature and enrich their leisure time.

## Chinese Ethnic Sculpture Park

Located inside Taipa Grande Nature Park, the Chinese Ethnic Sculpture Park is Macao's first ethnic-themed sculpture park. It is divided into a sculpture gallery and an exhibition hall.

## Hac Sa Reservoir Country Park

Hac Sa Reservoir Country Park is situated in a hilly forest area on the southeastern slopes of the central mountain of Coloane. The park occupies 371,000 square metres between the entrance of the Westin Resort Macau on Hac Sa Road to the east, and Chu Ku Tong pond, in front of Man Hong Un, to the south. The Hac Sa aquatic plant zone and aquatic plant watching zone are for ecological protection and education.

## Ka Ho Reservoir Country Park

Ka Ho Reservoir Country Park is situated on the northeast of Coloane island. The park faces Ka Ho Village to the east, separated by Barragem de Ka Ho Road. Seac Pai Van Reservoir lies to its west; and the golf course and Alto de Coloane Road lie to its south. It is bordered by a road that leads to the youth challenge centre in the north; and it stretches all the way down to a wooded and hilly area by the shoreline. Ka Ho Reservoir Country Park has an area of 81.8 hectares.

With Ka Ho Reservoir as its central point, the park boasts various facilities, including the Ka Ho Reservoir Trail, Northeast Trail, Dam Mural, Waiting Square, and Little Spring; as well as barbecue, and picnic areas; the Blossom Bridge; diversity games zone; Ka Ho Reservoir Outdoor Experimental Camp; and the Freshwater-Wetland Ecological Zone. With its educational and recreational features, Ka Ho Reservoir Country Park is an ideal place to spend leisure time.

## Population

Macao's resident population was estimated to be 644,900 as at 31 December 2016, representing a decrease of 1,900 or about 0.4 percent over the previous year.

On the same date, an estimated 47.4 percent of Macao's population were males, and 52.6 percent were females.

Natural factors form one reason for the increase in population prior to 2016, and natural population growth continued. In 2016, there were 7,146 newborn babies, 3.8 percent more than in 2015, and 2,248 deaths, representing an increase of 10.7 percent. The natural population growth rate was therefore 0.75 percent.

However, this increase was countered by a change in immigration, with the net number of immigrants declining by 6,800 in 2016. This was mainly due to the decrease in the number of foreign employers residing in Macao.

Most residents lived in Our Lady of Fatima Parish, comprising 37.8 percent of the total population.

## Birth and Death Rates

In 2016, the birth rate and death rate were 1.1 percent and 0.34 percent, respectively.

## Population Ageing

Macao's population is ageing because of the increasing life expectancy. At the end of 2016, 12.5 percent of the entire population was aged between 0 and 14, with senior citizens aged over 65 making up 9.8 percent of the population, compared with 14.8 percent and eight percent in 2006, respectively. During the year, the population of young children increased by 0.6 percentage points, and the population of elderly residents increased by 0.8 percentage point.

## Identification Bureau

Under the Basic Law of the Macao SAR, the MSAR Government is authorised by the central government to issue MSAR Passports to Chinese citizens who hold MSAR Permanent Resident ID cards, and to issue other types of MSAR travel permits to other legal residents of Macao. MSAR Passports and travel permits are valid for worldwide travel, and entitle their holders to return to Macao.

The Identification Bureau is under the administration of the Secretariat for Administration and Justice, and is responsible for the overall planning and operation of activities relating to the civil and criminal identification of Macao residents. It issues ID cards and certificates of criminal record, MSAR Passports, and other travel permits to Macao residents. It also issues certificates to substantiate the facts stated in official record, and arranges for the registration of non-profit juridical persons in accordance with relevant laws and regulations.

## Personal Identity Cards

Only Chinese citizens who are permanent residents in Macao with a Macao Resident ID card are eligible to apply for an MSAR Passport. A Chinese citizen who is a Macao Resident ID cardholder, but not a permanent resident of Macao and not eligible for other travel permits, may apply for an MSAR travel permit.

By 31 December 2016, the Identification Bureau had issued 583,981 MSAR Passports and 39,940 travel permits.

Under the Nationality Law of the People's Republic of China and the Interpretation by the Standing Committee of the National People's Congress on Several Questions Relating to the Application of the Nationality Law of the People's Republic of China in the Macao Special Administrative Region, any permanent resident of Macao with Chinese nationality and a Portuguese travel document may travel to other countries or regions with the Portuguese travel document as before. Therefore, such people may hold both a Macao SAR Passport and a Portuguese travel document at the same time.

The Identification Bureau is responsible for issuing Visit Permits for Residents of the Macao

SAR to the Hong Kong SAR (also known as “Visit Permits to the HKSAR”). Residents of the MSAR who are either Chinese or Portuguese citizens and who hold a Macao Resident ID card or an MSAR Resident ID card may apply for Visit Permits to the HKSAR. The bureau had issued 429,090 such permits as at 31 December 2016.

The Identification Bureau is also responsible for issuing Macao SAR Resident ID cards. As at 31 December 2016, there were 699,037 Macao SAR Resident ID card cardholders. Between 1 January and 31 December 2016, 16,915 residents received Macao SAR Resident ID cards for the first time.

## Nationality

Under Law No. 7/1999, the Identification Bureau is responsible for handling nationality applications from MSAR residents, including applications by foreign nationals or stateless persons for naturalisation; applications by Chinese citizens to renounce Chinese nationality; applications by foreigners who previously had Chinese nationality to restore Chinese nationality; applications by MSAR residents of both Chinese and Portuguese descent to choose either Chinese or Portuguese nationality; and applications by original Macao residents who are Chinese citizens with other nationalities to adopt Chinese nationality.

Between 20 December 1999 and 31 December 2016, 1,036 applications for naturalisation were approved; 533 people restored their Chinese nationality; 75 renounced their Chinese nationality; 2,481 successfully applied to adopt Chinese nationality; 62 opted for Portuguese nationality; and there were four applications for change of nationality.

## Certificate of Entitlement to Right of Abode

A certificate of entitlement to right of abode confirms the status of a permanent resident of the MSAR. Any person who claims to have right of abode in the MSAR but does not hold a valid Macao Resident ID card or MSAR Resident ID card and who does not live in any other region of the People’s Republic of China (except the Hong Kong SAR and Taiwan) must apply for a certificate of entitlement to right of abode.

Such people include Chinese citizens who have ordinarily resided in Macao for seven consecutive years before or after the establishment of the Macao SAR; children of Chinese nationality born outside Macao whose parents are Chinese nationals and permanent residents of Macao; people of both Chinese and Portuguese descent who have ordinarily resided in Macao for seven consecutive years before or after the establishment of the MSAR; and children of Chinese nationality or children born outside Macao who have not selected a nationality but intend to reside in Macao permanently and whose parents are permanent Macao residents of either Chinese citizenship or Portuguese descent. The certificate of entitlement to right of abode indicates its date of effectiveness, prior to which holders of the certificate have no right to enter or reside in Macao.

Between 20 December 1999 and 31 December 2016, the Identification Bureau issued 76,443 certificates of entitlement to right of abode.

## Certificate of Criminal Record

In August 1996, the Identification Bureau started to issue certificates of criminal record and certificates of special record for minors. The former is the sole and sufficient document to prove whether an applicant has any criminal record; while the latter is applicable to those under 16.

Between 1 January and 31 December 2016, the bureau issued a total of 92,630 certificates of criminal record. Of these, 73,264 were public applications, and 19,366 were agency applications. Among the 83 certificates of special record for minors that were issued, eight were to individual applicants, and 75 to public bodies.

## Immigration Controls

According to the Basic Law of the Macao SAR, the Government may impose restrictions on people from other countries or regions entering, staying in, and leaving Macao. The Immigration Department of the Public Security Police is responsible for entry and exit in Macao.

By 31 December 2016, citizens of 78 countries enjoyed visa-free access to Macao. Citizens of the Republic of Belarus and Armenia were newly granted visa-free access to Macao for a maximum stay of 30 and 90 days, respectively. The maximum length of stay for citizens of Uruguay was changed to 90 days. PRC passport or travel permit holders who have a valid air ticket and visa issued by the country or region of destination may stay for a maximum of seven days in Macao.

## Legal Immigration

Statistics provided by the Public Security Police show that 6,327 legal immigrants arrived from mainland China during 2016, of whom 1,733 were aged between 0 and 18; 2,691 between 19 and 37; 1,885 between 38 and 75; and 18 over 75. Of these, 3,854 were females, representing 60.9 percent of the total. Some 77 percent and 8.5 percent of the immigrants came from Guangdong Province and Fujian Province, respectively.

## Overstaying and Illegal Entry

In 2016, 26,691 overstayers were repatriated. They included 4,451 mainland Chinese, 78 Taiwan (China) residents, 89 Hong Kong residents, 2,491 foreign nationals, and 19,582 voluntarily repatriated mainland Chinese.

## Civil Registration

The Civil Registry is responsible for implementing regulations relating to the civil registration of births, parentage, adoption and child custody, marriage agreements, deaths, legal certification of the deaths of missing persons, and issuing relevant certified documents.

## Birth Registration

The Birth Registry is responsible for the registration of births in Macao, as well as the re-registration

of births of people aged 14 or over. The Civil Registry should be verbally notified of any birth in Macao by the parents or guardians within 30 days. The registry registered 7,167 births during 2016.

### **Marriage Registration**

The Civil Registry is responsible for handling applications for marriages, approving marriage registrations, hosting ceremonies for the signing of marriage certificates and registering marriages. A total of 3,893 marriages were registered during 2016.

### **Death Registration**

Family dependents or other relatives of a deceased person may register his or her death with the Civil Registry or its staff assigned to the registry's branches at Conde S. Januario Hospital and Kiang Wu Hospital. There were 2,362 death registrations during 2016.

### **Divorce by Mutual Consent**

The Civil Registry has the authority to process divorce by mutual consent. Applicants who have been married for over one year, have no children aged under 18, and have reached agreement on maintenance payments and ownership of their residences may submit applications to the Civil Registry. There were 565 divorce applications during 2016.



Joy of Farming





The Cultivation Camp is a piece of land behind the Hac Sa Park that was opened up by the Civic and Municipal Affairs Bureau (IACM) in 2015, and has an area of about 5,800 square metres. Inside the camp, there are farmland, an ecological pool, a work station, composting area and themed zones.

The IACM regularly organises New Farming Experience and Greening Workshops for the public, so Macao people may gain hands-on experience of being farmers and discover the joy of farming.

The area of each piece of farmland for cultivation by members of the public is 1.2 metres x 5 metres. Participants are mainly local families.

New Farming Experience encourages parents to cultivate the land with their children, so they can understand the meaning of “reaping what they sow”, hence learning to treasure and love nature.