

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.

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 29.9 square kilometres in 2012. The Macao peninsula accounts for 9.3 square kilometres (31.1 percent) of the current area, Taipa island for 7.4 square kilometres (24.8 percent), Coloane island for 7.6 square kilometres (25.4 percent), and the COTAI Reclamation Area for 5.6 square kilometres (18.7 percent).

Geology and Topography

Macao mainly comprises flat land, terraces and hills. The area of flat land (including reclaimed land) is 20.8 square kilometres, accounting for 69.6 percent of the total; granite hills cover six square kilometres, or 20.1 percent; and terraces cover 1.2 square kilometres, or four 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 6.3 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 15 kilometres is around the Macao peninsula and 35.4 kilometres is around the two islands.

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 increases 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 2012, roadside monitoring stations recorded “good” air quality on 54.1 percent of days, “acceptable” air quality on 38.4 percent of days, and “poor” air quality on 7.5 percent (25 days). In the high-density residential area of the Macao peninsula, the air quality was “good” on 69.7 percent of days, “acceptable” on 28.1 percent of days, and “poor” air quality on 2.2 percent (eight days). Ambient monitoring stations on Taipa recorded “good” air quality on 69.4 percent of days, “acceptable” air quality on 28.7 percent of days, and “poor” air quality on 1.9 percent (seven days). Ambient monitoring stations on Coloane recorded “good” air quality on 90.2 percent of days, “acceptable” air quality on 9.6 percent of days, and “poor” air quality on 0.3 percent (one day).

Other than increases in the ozone concentrations and carbon monoxide concentrations recorded at all the monitoring stations, concentrations of other pollutants were equal to or lower than those recorded in 2011. Starting from 2 July 2012, the air quality standard of Macao has been raised to the level of World Health Organization interim target-1, and the concentration of fine suspended particulates (PM_{2.5}) was included in measurement. During 2012, all monitoring stations recorded more days with “poor” air quality than in 2011 except the ambient monitoring station in Coloane. Overall, Macao’s air quality remained good. The annual average concentration of each pollutant was normal, meeting all the air quality standards.

Average Pollutant Concentrations in 2012

Monitoring Station	Respirable suspended particulates (µg/m ³)	Fine suspended particulates* (µg/m ³)	Sulphur dioxide (µg/m ³)	Nitrogen dioxide (µg/m ³)	Ozone (µg/m ³)	Carbon monoxide (mg/m ³)
Roadside	60.2	48.5	---	64.5	---	1.16
High-density residential area of Macao peninsula	52.5	38.1	1.8	38.5	15.5	0.67
High-density residential area of Taipa island ⁽ⁱ⁾	---	---	---	---	---	---
Taipa ambient	50.2	26.7	5.1	20.7	40.7	---
Coloane ambient	48.1 [#]	---	10.2	36.1	---	---

(i) The station suspends services due to maintenance works

* Announcement of suspended particulates concentration starts from 2 July 2012







Calculated with insufficient data

Comparisons between Pollutant Concentrations and the Daily Air Pollution Index (until 2 July 2012)

Air quality Index	Respirable 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 (mg/m^3)
0	0	0	0	0	0
50	100	60	80	80	5
100	150	150	150	160	10
200	350	800	280	350	17
300	420	1,600	565	600	34
400	500	2,100	750	800	46
500	600	2,620	940	1,000	57

Comparisons between Pollutant Concentrations and the Daily Air Pollution Index (from 2 July 2012)

Air quality Index	Respirable suspended particulates 24-hour average ($\mu\text{g}/\text{m}^3$)	Fine suspended particulates ($\mu\text{g}/\text{m}^3$)	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 (mg/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 2012, the Environmental Protection Bureau and the Public Security Police received 5,085 complaints about ambient noise, 654 cases or 14.8 percent less than the 2011 figure. The Environmental Protection Bureau received 386 of these complaints, representing a decrease of 72 cases or 15.7 percent compared with 2011; whereas the Public Security Police received the remaining 4,699 cases, a figure that was 726 cases or 18.3 percent more than that of 2011. Complaints received by the Public Security Police primarily related to people talking, shouting and being otherwise boisterous (1,718 cases), indoor renovation projects (843 cases), music and TV noise from domestic premises (558 cases), playing mahjong (233 cases), industrial or civil construction projects (294 cases), hitting objects (212 cases), factory and machinery noise (178 cases), and commercial music and karaoke (138 cases). These accounted for 8.83 percent (4,174 cases) of total cases. The numbers of cases related to people talking, shouting and being otherwise boisterous, indoor renovation projects, outdoor music, and music and TV noise from domestic premises increased by 47, 131, 64, and 58 cases respectively from the figure in 2011. On the other hand, numbers of cases related to workshop and machinery noise, moving objects, and playing mahjong decreased by 47, 30, and 11 cases respectively from the figure in 2011.

Of the complaints received by the Public Security Police, complaints about disturbances during the day-time (8.00am to 8.00pm) accounted for 22.28 percent of the total (1,047 cases), and mainly resulted from indoor renovation projects, industrial or civil construction projects, machinery noise, and music from domestic premises. Complaints about night-time (8.00pm to 8.00am) noise accounted for 77.72 percent (3,652 cases); and these primarily stemmed from people talking and shouting, music from domestic premises, playing mahjong, indoor renovation projects, hitting objects, machinery noise, barking of dogs, moving objects, commercial music, and outdoor music.

The Environmental Protection Bureau has set up a public services unit and launched a designated hotline in June 2012 as a permanent platform for public communication.

Environmental Noise Monitoring Network

Currently, Macao has four environmental noise monitoring stations – three on the Macao peninsula

and one on Taipa island. 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 their readings are published monthly 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.

In 2012, the Health Bureau continued an inshore waters quality monitoring scheme. The Macao Public Health Laboratory of the Health Bureau was responsible for sample collection and inspection, and result analysis and evaluation.

During 2012, the monitoring scheme maintained 12 monitoring stations and successfully conducted eight water sample collections, obtaining a total of 65 water samples.

As for monitoring of red tides, the Health Bureau has initiated the red tide outbreak sampling system twice during the year, in which four water samples were collected with the help of the Maritime Administration. The outbreaks of red tide were confirmed after inspection of the samples collected.

According to the Water Quality Monitoring and Evaluation Report of Macao Waters 2012, the overall pollution level of the individual indicators increased 12 percent over the previous year, the two key factors in pollution were inorganic nitrogen and activated phosphorus. Phosphorus compounds remained as the nutrients affecting planktonic algae outbreaks in Macao's inshore waters which still suffered from serious eutrophication. In October, there were red tide outbreaks in Cheok Van and Hac Sa waters, in which the dominant species was *Cochlodinium geminatum*. Monitored waters showed serious signs of non-metal pollution, while metal pollution remained at relatively low levels. Inner Harbour remained as the most seriously polluted waters which suffered from serious eutrophication. Compared with 2011, the overall water quality of Macao's inshore waters became worse, due to more serious metal pollution. However, there was no sign of returning for the worsening trend of water pollution recorded in recent years.

Water Quality Monitoring Network

The two water quality monitoring stations at Ilha Verde Dockyard and the Cotai Nature Reserves conduct round-the-clock monitoring of water quality.

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 monitors regularly the quality of water processed by the Macao Water Supply Company, and other water supply networks and reservoirs in the territory, so as to ensure 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 the Laboratory 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 constantly enhanced its analytical performance and improved 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 inspection technology the Laboratory has fulfilled international requirements. Currently, it possesses 150 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 2012, the Macao Peninsula Sewage Treatment Plant handled 58,525,248 cubic metres of sewage; Taipa Sewage Treatment Plant handled 7,738,189 cubic metres; Coloane Sewage Treatment Plant handled 7,444,416 cubic metres; the sewage treatment plant at Macau International Airport processed 44,939 cubic metres; and Crossborder Industrial Zone Sewage Treatment Plant handled 645,246 cubic metres.

Reflecting its commitment to the policy of environmental protection, the Environmental Protection Bureau continued to improve its sewage equipment, upgraded equipment in current sewage treatment plants, gradually increased the capability to treat domestic sewage in Macao and enhanced the quality of treated effluent. During 2012, the expansion project of Macao Peninsula Sewage Treatment Plant commenced, and the addition of a temporary odour-eliminating installation, a hydrogen sulphide monitoring station and an exhaust fan was completed.

Waste Management

Social development and economic growth have led to an increase in waste. According to the Statistics and Census Service, the total amount rose by about 41 percent between 2001 and 2011. Most of it comes from households and commercial and industrial operations. At present, incineration is the major mode of waste management in Macao, supplemented by landfill dumping.

Companhia de Sistemas de Resíduos, Lda. (CSR) has been contracted to undertake Macao's waste collection, urban cleaning operations and the cleaning and maintenance of public waste containers, under the Government's supervision. According to CSR, it collected 290,009 tonnes of waste in Macao during 2012, an average of 794.5 tonnes a day.

Waste Classification

To step up the programme for sorting and recycling waste in Macao, the number of public collection points was increased to 262 in 2012; 318 bodies (including schools, Government departments, associations and organisations) participated in the reusable waste sorting and recycling programme. The Civic and Municipal Affairs Bureau cooperated with residential buildings to promote the household waste sorting and recycling programme, and 3,321 buildings took part. During 2012, 488 tonnes of waste paper, 32 tonnes of metals and 64 tonnes of plastic were recycled under this programme.

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 inert solid waste produced through excavation, demolition, and construction. The solid waste includes debris, cement blocks, soft soil, marine clay, and melted residue. In 2012, the amount of construction waste buried in the landfill largely increased by 49.6 percent to 2,420,000 cubic metres.

Incineration Centre

Macao Incineration Centre is responsible for processing all Macao's household waste. It comprises two plants, with a total processing capacity of 1,728 tonnes of waste per day. During 2012, the centre received 365,680 tonnes of waste, an average of 1,002 tonnes a day. Some solid waste in Macao is collected from the sea by the Maritime Administration.

The waste heat produced by the round-the-clock incineration centre can be recovered and used for power generation. The power generated by the centre can supply up to 21 MW per hour of electricity at full load to the public grid – sufficient to meet the needs of over 33,000 households in Macao. During 2012, the incineration centre supplied 112,597 MW per hour of electricity to the public grid.

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 will be transported by means of air suction to a transfer station between Ponte da Amizade Avenue and Macao Wastewater Treatment Plant, from where it will be taken by trucks to the incineration centre.

Special and Hazardous Waste Disposal

The Special and Hazardous Waste Disposal Station, 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 2012, the station's total treatment capacity (including medical waste) was 2,408 tonnes, with discarded tyres comprising 28.8 percent of the treatment capacity.

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 Rules and Regulations on Water Supply and Drainage in Macao (Decree-Law No. 46/96/M, 19 August 1996), Prohibition Against Discharging Harmful Substances in Marine Jurisdictions (Decree-Law No. 35/97/M, 25 August 1997), Provisions on the Import and Registration of Vehicles Consuming Unleaded Petrol (Decree-Law No. 44/94/M, 22 August 1994), Measures to Control and Minimise the Use of Substances Destructive to the Ozone Layer (Decree-Law No. 62/95/M, 4 December 1995), and Prevention and Control of Environmental Noise (Decree-Law No. 54/94/M, 14 November 1994) and Provisions on the Sulphur Content of Vehicular Light Diesel Fuel Sold in the Macao Special Administrative Region (Executive Order No. 4/2006), the Emission Limits of Exhaust Pollutants by Newly Imported Heavy and Light Motorcycles (By-law No. 1/2008), the Table of Parameters of Emission of Exhaust Pollutants for Vehicles with Four-stroke Engines (Executive Order No. 1/2008), and the Standard for Acoustics (Decree-Law No. 241/94/M). 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. The Government 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; Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer; United Nations Framework Convention on Climate Change; the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the 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; the Plant Protection Agreement for the Asia and Pacific Region (with amendments made in 1967, 1979 and 1983); the Stockholm Convention on Persistent Organic Pollutants (POPs); 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 the 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: the International Convention on Oil Pollution Preparedness, Response and Co-operation 1990; International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (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.

Advisory Council on the Environment

The major responsibility of the Advisory Council on the Environment is consulting opinions from different social sectors regarding Macao's environmental protection, and providing recommendations on the study, formulation, implementation, coordination and promotion of environmental policies; providing advice on the year plan and activity reports, legislation and stipulation of rules and regulations regarding environmental protection, the implementation and development of Environmental Law and environmental reports; and providing recommendations on measures concerning the promotion of environmental protection, education and public participation.

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. Acceptance of applications began on 12 September 2011.

The objectives of establishing the Environmental Protection and Energy Conservation Fund are to subsidise enterprises and community groups in Macao to purchase and switch to products and devices which protect the environment and save energy, to increase the 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 start-up fund of the Environmental Protection and Energy Conservation Fund was 200 million patacas.

The Environmental Protection and Energy Conservation Fund is supervised by the Chief Executive and supported by The Environmental Protection Bureau in terms of technology and

administration. The Fund consists of a managing committee and an accreditation committee.

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 social groups. Once a funding application is approved, 80 percent of the total cost of purchasing and switching to green products and devices are subsidised, with an upper limit of 500,000 patacas.

In 2012, The Environmental Protection Bureau received over 1,700 applications for subsidies, in which over 680 applications were approved, involving subsidies of more than 60 million patacas.

Promotion of Environmental Protection Education

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

A total of 86,406 people participated in the 125 events the bureau held and supported during 2012, including Earth Day programmes, a series of activities for Macao Environmental Protection Week, a series of activities for World Car Free Day, the Green School Projects: the Second Environmental Protection Teaching Kit Design Award Scheme, Macau Food Festival - Waste Reduction Scheme and the Green Points: Double Fun programme.

The Environmental Protection Bureau has formulated and launched its Proposal on Eco-friendly Product Specification, providing suggestions on eco-friendly specification on 50 common products, as well as the Eco-friendly Merchandising Guidelines for Public Departments. These two documents provide references for eco-friendly merchandising in different sectors. The Environmental Protection Bureau also extended training programmes for eco-friendly merchandising to green hotels, green enterprises and green schools.

The Environmental Protection Bureau issued the first Macao Green School Environmental Protection Management Guidelines, continued the Public Awareness Survey on Environmental Protection, and strengthened the Green School Project, aiming at promoting environmental protection through different media and encouraging residents to adopt a green and low-carbon way of life.

The number of participating hotels of the Macao Green Hotel Award increased from eight in 2007 to 23 in June 2012, representing 24 percent of Macao hotels and about 46 percent of hotel rooms. Award-winning hotels achieved outstanding performance in different areas, including energy saving, water saving, reducing waste, compliance with laws and regulations regarding environmental protection, noise control, maintaining indoor air quality, light pollution control, customer and community relation, and eco-friendly merchandising.

Regional Cooperation on Environmental Protection

The 2012 Macao International Environmental Co-operation Forum (2012 MICEF) was organised

by the Government, supported by the National Development and Reform Commission and the Ministry of Science and Technology and the Environmental Protection Bureau, co-organised by provincial/regional governments in the Pan-Pearl River Delta (PPRD) area, and hosted by the Macao Trade and Investment Promotion Institute and Macao Environmental Protection Bureau, and was held from 29-31 March 2012. The theme of 2012 MICEF was “Sustainable Cities – The Way Towards a Green Future”. The event attracted over 8,500 representatives from 28 countries and regions, with a total of 35 contracts signed during the three-day forum. As for the green forum, experts from around the world actively participated in six official forums with 55 speakers and moderators from different countries and regions. There were about 1,200 participants for the six forums. These figures reflect the MICEF functional role as a green platform was strengthened that it promoted development of environmental protection industry and technology.

As for the PPRD region, the bureau participated in the 2012 Coordinator Working Meeting and the 8th meeting of the Joint Conference on Pan-Pearl River Delta Regional Environmental Protection Cooperation, the 7th Fujian Province Environmental Protection Projects Trade Fair and a seminar on automobile exhaust emission control.

Appointed by the Environmental Protection Bureau, the South China Institute of Environmental Sciences of State Environmental Protection Administration completed a research on water quality of Macao’s inshore waters, and has commenced a study of the recent implementation and performance of Macao’s environmental protection planning, as well as the continued study of permanent organic pollutants. The bureau also implemented, together with the State Environmental Protection Administration, various projects related to transfer of waste, international conventions on environmental protection, nuclear safety information sharing, and emergency information sharing.

The Ministry of Science and Technology (MOST) and Macao’s Environmental Protection Bureau jointly appointed Tsinghua University to continue two research projects, namely the Demonstration of Integrated Exhaust Emission Control for Motor Vehicles in Macao and the Demonstration of Electronic Waste Management and Pollution Control in Macao.

In September 2012, the Social Development Department of the Ministry of Science and Technology, the Environmental Protection Bureau and the Transport Bureau jointly organised a seminar on the development of electric vehicle technology.

To implement the Outline of the Plan for the Reform and Development of the Pearl River Delta (2008-2020), the Department of Housing And Urban-Rural Development of Guangdong Province, the Environmental Bureau of the Hong Kong SAR Government and Macao’s Secretary for Transport and Public Works jointly announced the Regional Cooperation Plan on Building a Quality Living Area in June 2012.

As for cooperation between Guangdong and Macao, the pollution treatment of the Canal dos Patos commenced in 2012. Macao has also joined the Pearl River Delta Regional Air Quality Monitoring Network, and participated in cooperation and exchanges on solid waste treatment, environmental protection industry and environmental education and promotion. The two regions continued to jointly organise the World Environment Day Carnival 2012 in Hong Kong, Macao and five cities in Guangdong Province. The mechanisms of regional pollution information sharing and collaborative prevention, and the Guangdong-Macao Environmental Protection Cooperation Task Force have been refined.

Hong Kong and Macao also joined hands in environmental protection. During the year, Macao attended the 4th Meeting on Environmental Protection Cooperation between Hong Kong and Macao for sharing of environmental protection policies and technology information. The Environmental Protection Bureau led a delegation of government officials, representatives from organisations and the industry to participate in the Eco Expo Asia 2012, and set up the Macao Pavilion in cooperation with the Macao Trade and Investment Promotion Institute.

The Zhuhai-Macao Environmental Protection Cooperation Task Force held a working meeting in 2012 to reach consensus between the two regions on thorough treatment of the pollution problem of Canal dos Patos, and promote environmental cooperation in view of the opportunity brought by the development of new connecting roads between the two regions. The Environmental Protection Bureau and the Zhuhai Environmental Protection Bureau continued to jointly organise the 2012 Macao-Zhuhai Cycling Tour for promotion of low-carbon concept.

International Cooperation on Environmental Protection

The Environmental Protection Bureau continued to cooperate with the Portuguese Environment Agency in compiling the list of air pollutants and the drafting of the Report on the State of the Environment of Macao 2010.

The bureau also held workshop on EU's Experience in Establishment and Implementation of the Environmental Impact Assessment System, in which two environmental impact assessment experts from the European Union were invited to share their experience.

Signing of Cooperation Agreements

The Environmental Protection Bureau signed a letter of intent for cooperation with the Environmental Science and Engineering Department of Tsinghua University on development of environmental policies, environmental technology research and enhancement of environmental protection capacity.

Environmental Protection Planning in Macao

The Environmental Protection Plan of Macao (2010-2020) was announced in September 2012.

The plan consists of four core concepts: sustainable development, low carbon development, public participation and regional cooperation. With a vision of "Building a Low Carbon Macao, Creating Green Living Together", it aims at improving the living environment of Macao residents and protecting residents' health. The plan has three principal themes, namely Optimizing the Environment Suitable for Living and Tourism, Promoting a Conservation and Recycling-oriented Society and Integrating into the Green and Quality Region, of which action plans for 15 areas of concern will be established according to priority. Implementation progress of the plan in each district will be distinctly controlled by district-based and category-based management to minimise the environmental impact of economic and social development. Moreover, 11 green indicators are established as a guideline to the implementation of the plan and realisation of short-term, medium-term and long-term environmental protection goals. The plan aims at gradual improvement of the environment.

Exploration on the Establishment of an Environmental Impact Assessment System

The Environmental Protection Bureau has issued a Discussion Paper on the Establishment of an Environmental Impact Assessment System to gather opinions from all sectors. The second phase of the development of environmental impact system and related works has commenced to facilitate the progress of environmental assessment systemisation.

Indoor Air Quality

After conducting three phases of studies of Macao's indoor air quality, the Environmental Protection Bureau has gathered the information of air quality at various kinds of indoor public places. Upon compilation and analysis of the data, the bureau has begun formulating guidelines for Macao's indoor air quality.

Establishment of the Environmental Impact Assessment System

To ensure the sulphur content of vehicular diesel fuel in Macao does not exceed 0.005 percent, as stated in the Executive Order No. 4/2006, on three occasions – in June, September, and November 2012, the Environmental Protection Bureau took samples for analyses and testing from fuel pumping stations in Macao, Taipa and Coloane, and the Ka Ho Fuel Oil Terminal. The results indicated that the sulphur content in all samples was below the maximum permitted level of 0.005 percent.

During 2012, to combat motor vehicle exhaust emissions, the bureau developed a proposal on the formulation of Macao Vehicle Exhaust Emissions Standards and Improvements of Inspection System and started the related consultation process. During the year, the consultation on the Standards of Unleaded Petroleum and Light Diesel for Motor Vehicles was completed. The bureau also started its research on the standards and pollutants of kitchen exhaust and other regular sources of air pollutions.

Complaints and Technical Opinions

The Environmental Protection Bureau received 749 complaints during 2012. Of these, 313 concerned noise; 286 concerned air pollution; 68 concerned combinations of noise and air pollution; five concerned combinations of noise and other pollution; ten concerned combinations of air and other pollution; 29 concerned environmental hygiene; and 38 were for miscellaneous reasons.

At the request of the Macao Government Tourist Office, during 2012 the Environmental Protection Bureau conducted 60 inspections prior to granting or renewing industrial licences and assisted in nine noise surveys. It provided technical advice in response to written queries concerning 87 licence applications filed by karaoke parlours and bars, and one written query on other areas; conducted inspections concerning banning illegal lodgings, and sent officers to 116 related activities. It also participated in seven factory inspections, providing nine technical recommendations at the request of the Economic Services Bureau. At the request of the Lands, Public Works and Transport Bureau,

it participated in the inspection of two places for evaluation of nuisances and provided 54 technical recommendations in response to written queries. At the request of the Civic and Municipal Affairs Bureau, it provided 165 technical recommendations in response to written queries. At the request of the Public Security Police, it assisted in seven noise surveys. It also advised on 14 applications to import CFCs, which are controlled substances under Decree-Law No. 62/95/M.

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 a north wind, 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 southwesterly 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 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. May 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 September, with July and August as its peak period.

Weather Overview

General Situation

In 2012, Macao's average annual temperature and relative humidity were close to average, while the total rainfall, total evaporation level and total hours of sunshine were lower than average.

Five tropical cyclones affected Macao in 2012. They were: Severe Tropical Storm Talim from 17-20 June, Tropical Storm Doksuri from 28-30 June, Typhoon Vicente from 21-24 July, Typhoon Kai-tak from 15-17 August, and Typhoon Tembin from 24-27 August. Typhoon Signal No. 8 was issued as a result of Doksuri and Kai-tak, while Typhoon Signal No. 9 was issued as a result of Vicente.

During 2012, 17 strong monsoon warnings (Black Ball) were issued, 10 more than in 2011.

Three rainstorm warnings were issued during 2012, one more than in 2011.

In 2012, a total of 72 thunderstorm warnings were issued. The first thunderstorm warning was issued on 5 April, and the last one on 23 November.

As for storm surge warning, three yellow storm surge warnings and two red storm surge warnings were issued during 2012.

Summary of Severe Weather Warnings Issued in 2012			
Warning / Signal Type		Frequency	No. of Warning Reports Issued
Tropical Cyclone Warning	No. 1 Alert Signal	5	39
	No. 3 Strong Wind Signal	6	19
	No. 8 Northeast Gale Signal	1	9
	No. 8 Southeast Gale Signal	3	20
	No. 8 Southwest Gale Signal	0	0
	No. 8 Northwest Gale Signal	0	0
	No. 9 Increasing Gale Signal	1	3
	All Signals Lowered	5	5
Strong Monsoon Warning (Black Ball)		17	47
Rainstorm Warning		3	8
Thunderstorm Warning		72	184
Storm Surge Warning		3	18

Temperatures

Macao had an average annual temperature of 22.3°C during 2012, which was close to normal. The highest and the lowest average temperature were 28.6°C in August and 13.0°C in January, respectively. The hottest day was 21 July, when the temperature rose to 36.1°C; whereas the coldest day was 25 January, when the temperature fell to just 5.0°C.

Relative Humidity

The average relative humidity during 2012 was 80 percent, which was close to the climate normal. April saw the highest monthly average relative humidity, at 88 percent; whereas the lowest was 70 percent in October.

Rainfall

Total rainfall during 2012 was 1,556.0 millimetres, which was 502.1 millimetres or 24 percent less than climate normal. The highest monthly rainfall was recorded in July at 394.4 millimetres, 97.0

millimetres above normal. Also, total rainfall in March was only 18.8 millimetres, 70.5 millimetres less than the climate normal of that month.

Evaporation

The total evaporation level in 2012 was 734.4 millimetres, which was 210.7 millimetres less than climatological normal. The evaporation levels from January to December 2012 were both lower than climatological normal of the same period.

Sunshine

During 2012, Macao had 1,545.3 hours of sunshine, 228.6 hours less than normal. The most hours of sunshine were recorded in July, totalling 235.8 hours, 12.6 hours above normal. The least hours of sunshine were recorded in February, amounting to only 27.5 hours, which was 51.9 hours less than normal. Moreover, there were only 84.1 hours of sunshine in December, which was 75 hours less than normal.

Wind

During 2012, Macao was subject to predominantly easterly winds from May to June, and from September to October; northerly winds in January, and from November to December; north-northeasterly winds in February and March; southeasterly winds in April, southerly winds in July, and southwesterly winds in August. Wind speeds averaged 13.2 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 and two marine and weather forecasts for the South China coastal area, all of which are broadcast daily. The SMG provided 1,830 weather reports and 732 marine and weather forecasts for the South China coastal area during 2012.

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. 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. The SMG also cooperates with Sai Van Bridge Management Company and the Lands, Public Works and Transport Bureau, to display real-time weather information on electronic message boards at both ends of the bridge and some main street junctions. Severe weather warnings are also displayed on

the electronic boards at Sai Van Bridge.

The SMG also issues timely warnings of adverse weather conditions, including tropical cyclones, strong monsoons (black ball), rainstorms, thunderstorms and storm surges. The Rainstorm Floods Alert SMS Service and the Hot/Cold Weather Alert SMS Service are also introduced by the bureau.

A round-the-clock, Automatic Air Quality Monitoring Network and Ultraviolet (UV) Monitoring System enable the SMG to summarise daily air quality and UV indices, and report them to the public together with an air quality forecast for the following day.

The SMG has introduced the Mobile WebWeather Service, the Temperature Index and the Maximum UV Index. To cater for mainland China tourists in Macao, a Macao page was launched on the China Weather Website in 23 March 2011. Seven-day weather forecast information is uploaded three times a day to the China Meteorological Administration website.

Real-time weather conditions, weather forecasts, and extreme weather warning information are available via SMS for registered customers of four mobile phone service providers.

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 high-altitude air temperatures, wind maps, and weather forecasts. The centre provided about 19,281 such documents to departing flights during 2012.

Monitoring Network

The SMG collects weather data 24 hours a day via its Automatic Weather Station Network of 11 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 Monitoring 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 boasts a VCS MTSAT ground meteorological reception and processing system to receive Japanese MTSAT satellite information, a Huayun geostationary meteorological satellite reception and processing system to receive Fengyun 2E satellite information, a low-level wind profiler, a cloud height meter and three transmissiometers. In 2012, SMG purchased a new CMACast geostationary meteorological satellite ground reception and processing system, which will operate soon, to replace the old FengYunCast system. A new X-band Doppler weather radar officially began operations in 2011, releasing information to the public through the internet. The SMG joined hands with the Zhuhai Meteorological Bureau on installing a S-band Doppler weather radar at Jiaoding Mountain in Sanzao Town, Zhuhai, to further enhance the meteorological monitoring ability and standard of whether forecast and warning of

both Zhuhai and Macao. The procurement of radar was completed in 2012 and it is planned to be installed and tested by early 2014. Also, the SMG has a lightning sensor 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, which includes nine land water level monitoring stations set up on the streets of various flooding black spots, two tide monitoring stations set up along the coast, and one wave monitoring station set up in the sea. The network operates 24 hours a day, to provide real time data on flooding and tides.

The SMG established the Air Quality Monitoring Project in partnership with other Government departments. The SMG now employs a fully automated air monitoring network to measure major pollutants that jeopardise Macao's air quality. Macao now has six automatic air quality monitoring stations. In 2011, the SMG purchased and modified a vehicle to serve as a mobile air quality monitoring station. The SMG is gradually purchasing equipment to install in the vehicle. Moreover, the SMG has adopted a new air quality standard from 2 July 2012, raising the air quality standard to WHO interim target-1.

The SMG has two seismological monitoring stations, one in Ka Ho Lighthouse on Coloane, and the other in its Taipa Grande headquarters on Taipa. An analogue seismograph is installed inside the Ka Ho Lighthouse, while a digital seismograph and a deep shaft (30 metres from ground level) digital seismograph are installed in the Taipa Grande headquarters. During 2012, the SMG did not record any felt earthquake.

The SMG's headquarters is equipped with an environmental radiation monitoring station, mainly for detecting Gamma radiation dose rate in the atmosphere and announcing the results on website.

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 and overseas meteorological agencies and academic organisations.

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

The SMG also keenly takes part in meteorological science meetings and exchange activities conducted by its mainland and Hong Kong counterparts. In January 2012, the SMG organised the 26th Guangdong-Hong Kong-Macao Seminar on Meteorological Science and Technology and the 17th Guangdong-Hong Kong-Macao Meeting on Cooperation in Meteorological Operations, discussing the development of Meteorological technology application.

The Workshop on Applications of Space Technology to Enhance the Activities of the Typhoon Committee was held in Macao in February 2012. It is jointly organised by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), World Meteorological Organization and the Typhoon Committee Secretariat. The workshop was financially supported by the Japan Aerospace Exploration Agency (JAXA) and co-organised by the Macao Meteorological

and Geophysical Bureau. Through training up space application experts, the workshop aims at enhancing the ability of disaster management on space applications for urban flood risk.

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 Fairy Lake 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. As it was discovered in Macao, its Latin name includes the word Macao.

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 Gugertree (*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 Gugertree (*Schima superba*). There are 491,845 trees in the outlying islands' replanted woodlands.

By the end of 2008, Macao had 16,231 shade trees, an increase of 601 trees compared with 2007. The Macao peninsula is crowded, with many construction projects, especially involving road construction, greatly affecting the shade trees. The development of new green areas was also difficult, and consequently the growth in the number of shade trees was relatively small.

In terms of green belts, the main species of plants in the green belt of Macao are the Dwarf Yellow (*Duranta repens*), Chinese Banyan (*Ficus microcarpa*), Chinese Hibiscus (*Hibiscus rosa-*

sinensis), Purple Knight (*Alternanthera dentata*), Royal Palm (*Roystonea regia*), Norfolk Island Pine (*Araucaria heterophylla*), *Arachis duranensis*, Camel's Foot Tree (*Bauhinia variegata*), Canna lily (*Canna indica*), *Duranta repens* 'variegata', Tall Bottle-brush (*Callistemon viminalis*), East Indian Lotus (*Nelumbo nucifera*), Sunshine Tree (*Cassia surattensis*), Chinese Banyan (*Ficus microcarpa*), Bamboo Palm (*Chrysalidocarpus lutescens*), Painted Copper Leaf (*Acalypha wilkesiana*), Indian Azalea (*Rhododendron simsii*), Nerium Oleander (*Nerium indicum* Mill.), Kapok tree (*Ceiba pentandra*), and Cotton tree (*Bombax ceiba*). These are mainly admired for their leaves, rather than their flowers.

Fauna

Macao is small. The development of land and expansion of urbanisation create detrimental effects on the survival and scope of activities of wild animals. The numbers of species and populations of wild animals in Macao are decreasing. Through continued research on wild animals in Macao, in 2012, 12 new bird species, four new fish species and two new bat species were recorded. While development and building cities, we should strengthen protection of the last habitats of wild animals, so that man and nature can coexist in harmony.

Amphibians in Macao are declining in numbers. As most of the amphibians need natural waters as their living and breeding space, the scarcity of unpolluted waters in Macao leads to the decrease in the species 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 a better shelter for amphibians.

The commonest wild mammals are bats, rats and red-bellied tree squirrels. Bats mainly inhabit Coloane and Taipa. In 2012, two species, Bent-Winged Bat (*Miniopterus pusillus*) and Common Pipistrelle (*Pipistrellus pipistrellus*), were newly recorded, and four suspected cryptic species were discovered in Coloane by ultrasonic inspection. 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. 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. The Civic and Municipal Affairs Bureau has monitored birds since 2006. In 2012, 122 species from 14 orders and 41 families were recorded, of which dominant species were Chinese bulbul (*Pycnonotus sinensis*, terrestrial) and Little Egret (*Egretta garzetta*, waterbirds). There were nine common species, of which terrestrial

birds more than water birds. Among these, five common species were terrestrial birds, including 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 water birds, including Kentish Plover (*Charadrius alexandrinus*), Black-crowned Night Heron (*Nycticorax nycticorax*), Grey Heron (*Ardea cinerea*), and Chinese Pond Heron (*Ardeola bacchus*). There were 12 species newly recorded in 2012, including Rose-ringed Parakeet (*Psittacula krameri*), Greater Spotted Eagle (*Aquila clanga*), Greater Painted-snipe (*Rostratula benghalensis*), Red-necked Stint (*Calidris ruficollis*), Southern Lapwing (*Vanellus chilensis*), Richard's Pipit (*Anthus richardi*), Grey-headed Lapwing (*Vanellus cinereus*), White-crowned Forktail (*Enicurus leschenaulti*), Blue-fronted Redstart (*Phoenicurus frontalis*), Northern Shoveler (*Anas chlypeata*), Rock Dove (*Columba livia*) and Common Shelduck (*Tadorna tadorna*).

After six years of survey from 2006 to present, 208 species of birds from 14 orders and 50 families have been recorded.

There are abundant stocks of fish 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. In 2012, four new species were found, namely *Channa striata*, *Metzia lineata*, *Pseudogobius javanicus* and *Mugilogobius chulae*.

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

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.

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 with suitable habitats. During 2012, 55 of the rare Black-faced Spoonbill were spotted in the nature reserve.

To enhance the ecological function of the ecology conservation zone, the Environmental Protection Bureau carried out an optimisation project in 2012, which includes removing weeds to enlarge the birds' foraging area in mudflats; building two bird-watching houses, which were opened in February 2012 for the public to watch birds from a closer distance; the paths towards the bird-watching houses were set up as nature trails to strengthen the education role of the ecology zone.

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

Nestled against a hillside, the Giant Panda Pavilion covers an area of about 3,000 square metres, with an appearance designed to resemble nature. The panda living quarters are under a hi-tech translucent film roof that ensures adequate natural lighting. Both the indoor and outdoor enclosures of the Giant Panda Pavilion are modelled on the natural terrain of panda habitats, with streams and cascades, shrubs and trees, a wooden resting platform and rocks for climbing. Everything is designed and fine-tuned to the pandas' needs and comfort.

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 Ethnicity Sculpture Park

Located inside Taipa Grande Nature Park, the Chinese Ethnicity Sculpture Park is Macao's first ethnic-themed sculpture park. It is divided into a sculpture gallery and an exhibition hall. In 2012, it attracted 6,252 visitors.

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 582,000 as at 31 December 2012. This is 24,600 more than the revised 2011 figure of 557,400, an increase of 4.4 percent.

On the same date, an estimated 48.2 percent of Macao's population were males, and 51.8 percent

were females. Some 11.6 percent were aged 14 and under, 80.8 percent were between 15 and 64, and 7.7 percent were over 65.

Natural factors form one reason for the increase in population. In 2012, there were 7,315 newborn babies, 25 percent more than in 2011, and 1,841 deaths, a slight decrease of 0.2 percent. The natural population growth rate was therefore 0.96 percent.

Immigration was another factor. Regarding immigration, the number of immigrants was estimated to be 19,200, including immigrants from mainland China, foreign nationals with legal residency and non-resident workers, while there were an estimated 1,862 emigrants.

Most residents lived in Our Lady of Fatima Parish, composing 39.7 percent of the total population.

Birth Rate

According to the revised population index from 2006 to 2012, the natural population growth rate rose from 0.5 percent in 2006 to 0.96 percent in 2012; while the gross birth rate increased from 0.81 percent of the population in 2006 to 1.29 percent in 2012.

Population Ageing

Although the birth rate has been rising since 2005, Macao's population is ageing because of the declining birth rate and increasing life expectancy. At the end of 2012, 11.6 percent of the entire population was aged between 0 and 14, compared to 11.8 percent in 2011 and 14.8 percent in 2006. Senior citizens aged over 65 made up 7.7 percent of the population, compared with 7.3 percent in 2011 and 7.0 percent in 2006. Compared with the 2011 figures, the population of young children dropped 0.2 percentage points, but the population of elderly residents increased slightly by 0.4 percentage points.

Identification Services Bureau

Under the Macao Basic Law, the MSAR Government is authorised by the Central People's 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 Services Bureau 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 the 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 2012, the Identification Services Bureau had issued 376,776 MSAR Passports and 22,043 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 Services 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 the Macao Resident ID card or the MSAR Resident ID card may apply for Visit Permits to the HKSAR. The bureau had issued 393,896 of these up to 31 December 2012.

The Identification Services Bureau is also responsible for issuing Macao SAR Resident ID cards. As at 31 December 2012, there were 636,364 Macao SAR Resident ID cardholders. Between 1 January and 31 December 2012, 20,785 residents received Macao SAR Resident ID cards for the first time.

Nationality

Under Law No. 7/1999, the Identification Services 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 2012, 796 applications for naturalisation were approved; 500 people restored their Chinese nationality; 55 renounced their Chinese nationality; 1,109 successfully applied to adopt Chinese nationality; 45 opted for Portuguese nationality; and there were three 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 2012, the Identification Services Bureau issued 61,612 certificates of entitlement to right of abode.

Certificate of Criminal Record

In August 1996, the Identification Services 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 2012, the bureau issued a total of 92,496 certificates of criminal record. Of these, 76,173 were public applications, and 16,323 were agency applications. Among the 118 certificates of special record for minors that were issued, 14 were to individual applicants, and 104 to public bodies.

Immigration Controls

According to the Basic Law, 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.

As at May 2013, citizens of 74 countries and regions enjoyed visa-free access to Macao. Tourists with a valid passport or travel document may normally stay in Macao from 14 days to a maximum of 90 days. In addition, British nationals are allowed to stay in Macao for a maximum of six months. Holders of a Hong Kong permanent resident ID card or a return permit to Hong Kong may stay for a maximum of one year.

PRC passport holders who have right of abode in foreign countries may stay for a maximum of 30 days in Macao.

Legal Immigration

Statistics provided by the Public Security Police show that 4,060 legal immigrants arrived from the mainland during 2012, of whom 900 were aged between 0 and 18; 1,949 between 19 and 37; 1,179 between 38 and 75; and 32 over 75. Of these, 2,628 were females, representing 64.73 percent of

the total. Some 68.28 percent and 9.48 percent of the immigrants came from Guangdong Province and Fujian Province, respectively.

Overstaying and Illegal Entry

According to statistics provided by the Public Security Police, 37,261 overstayers were repatriated in 2012. They included 3,603 mainland Chinese, 65 Taiwan residents, 116 residents of the Hong Kong SAR, 3,062 foreign nationals, and 30,415 voluntarily repatriated mainlanders.

A total of 1,151 illegal immigrants were repatriated during 2012, 739 of whom were males and 412 were females. A total of 153 people were referred to the Public Prosecutions Office, and 120 of these were repeat offenders, and 33 had made false declarations. Some 74 people claimed to have lost their travel documents.

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 7,223 births during 2012.

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 3,783 marriages were registered during 2012.

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 1,904 death registrations during 2012.

Divorce by Mutual Consent

Applicants for divorce by mutual consent must have been married for over one year, have no children aged under 18, and have reached agreement on maintenance payments and ownership of their present residences. Applications should be submitted to the Civil Registry. There were 612 divorce applications during 2012.



Aerial view of Macao

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 29.9 square kilometres in 2012.



