Geography

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

Weather and Climate of the Greater Bay Area

Edited by The Education University of Hong Kong

Personal, Social and Humanities Education Section, Curriculum Development Institute, Education Bureau

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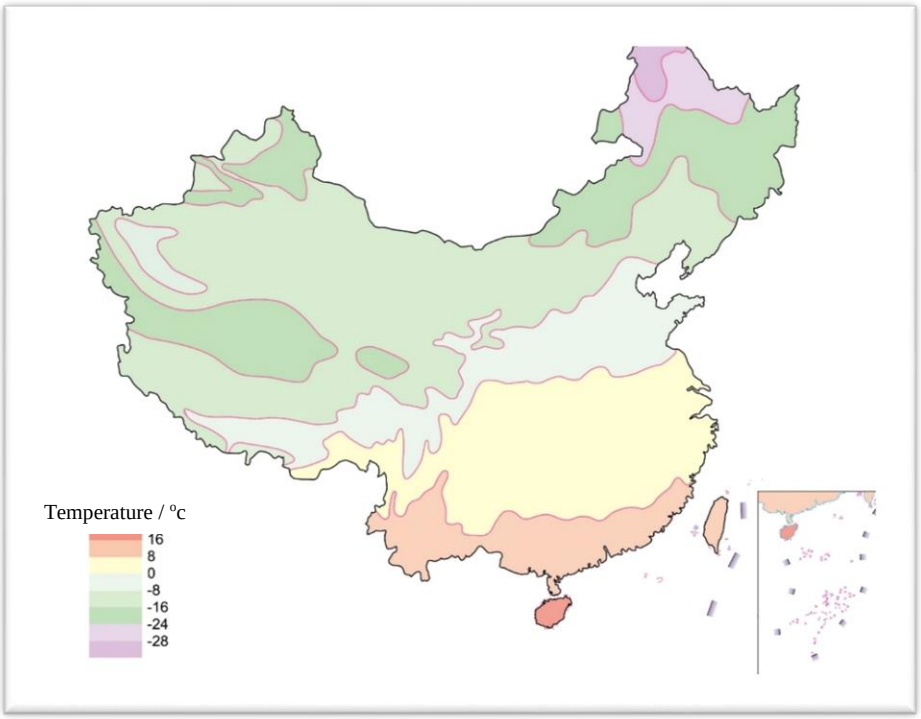
1 Introduction

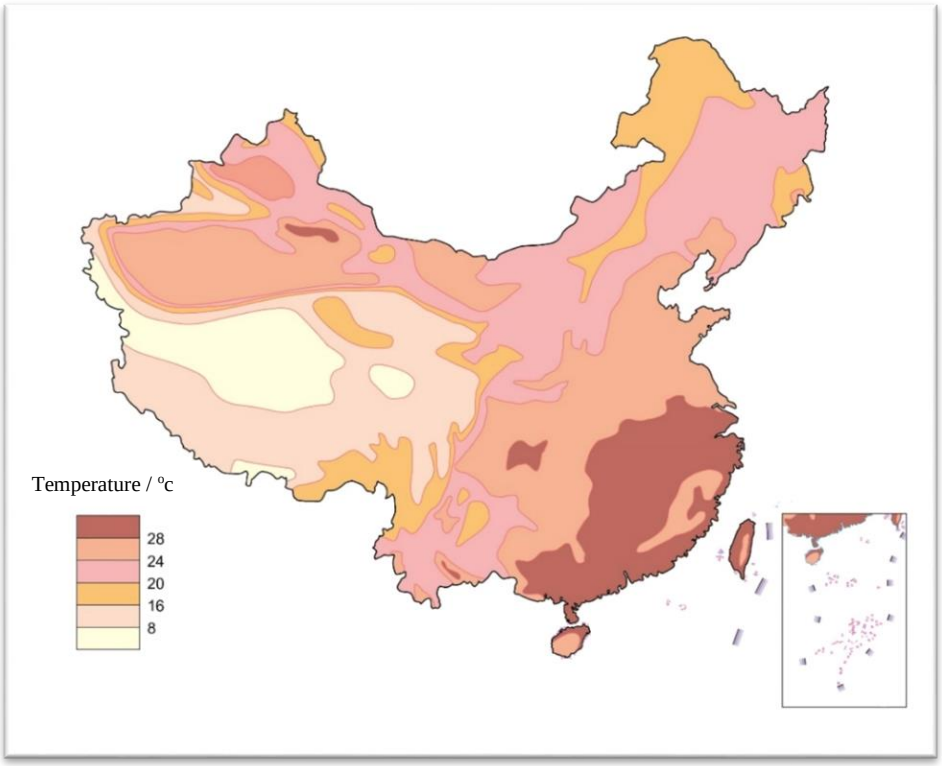
There are five major types of climate in China, including, temperate monsoon climate (mainly in the eastern part of China by the north of Qingling Mountains and Huaihe River, temperate semi-arid regions, and to the east of arid regions), temperate continental climate (mainly by the west of Daxing'an Mountains, Yinshan Mountains, Helan Mountains, Qilian Mountains and Bayan Har Mountains, and by the north of Kunlun Mountains, Altay Mountains, Qilian Mountains and Hengduan Mountains), subtropical monsoon climate (mainly in the eastern part of China by the south of Qingling Mountains and Huaihe River and by the north of the tropical monsoon climatic region), subtropical monsoon climate (mainly at the eastern coastal area of 10°N to 20°N), and highland climate (the Qinghai-Tibet Plateau). Due to the complexity in topography, variations in temperature, humidity and precipitation can still exist in places with the same type of climate （Government of the People's Republic of China, 2005）. The Guangdong-Hong Kong-Macao Greater Bay Area (Greater Bay Area) that encompasses the Hong Kong Special Administrative Region (SAR), Macao SAR, Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, and Zhaoqing is located in the region with subtropical monsoon climate, which is characterised by having a relatively warm winter and hot summer with distinct seasonal variations (Figure 1 and Figure 2). The region is often affected by extreme weather events like typhoons and rainstorms, for example, when the northeast monsoon happens to meet the warm and moist air associated with tropical cyclones, it would result in a windy and rainy weather. Extreme weather events are becoming more prevalent as global warming intensifies.

Figure 1: Mean temperature distribution of China in January



Source：National Meteorological Information Centre

Figure 2: Mean temperature distribution of China in July



Source: National Meteorological Information Centre

2 Characteristics of seasons

The Greater Bay Area has four distinct seasons, with longer winter and summer and shorter spring and autumn. Summer in the Greater Bay Area is generally humid and hot, winter is cold and dry, spring is warm and foggy, and autumn is warm and dry. Winter monsoon dissipates during March as easterly winds becomes the prevailing wind in spring. The prevailing wind originating from the warmer ocean increases the humidity in spring. Warm and humid air masses cool off gradually as they travel inland, and ultimately condense into fog. The Greater Bay Area has a shorter spring season, and fogs commonly form during this season. Sometimes, cold air masses from the continent may travel southward and reach the Greater Bay Area. If the stronger cold air masses travel across Nanling Mountains, northerly winds would be formed in the region. When the dry and cold continental air masses and warm and human ocean air masses encounter, cold fronts would be formed. Hong Kong Observatory（2014）pointed out that as cold fronts move, water vapour in the air would cool down and form crystals and droplets, as these crystals and droplets aggregate, clouds will be formed and eventually lead to rain. Therefore, when cold air masses travel south in spring, it often result in a cloudy and rainy weather in the Greater Bay Area.

Summer monsoons are generally most active from early June to mid-August. But sometimes, summer monsoon may start causing influence to the weather of the Greater Bay Area in April. The beginning of summer in the Greater Bay Area is marked by the alternating influence of the southeast monsoons from Pacific Ocean and the southwest monsoons from South China Sea. In summer, the land absorbs heat quicker than the ocean, temperature above the ground rises, air expands and rises, leading to the formation of a low-pressure area in the land area. At the same time, as the ocean absorbs heat more slowly, it has a relatively lower temperature, and a high-pressure area would be formed above the ocean. The Asian continent receives a lot of sunlight during summer, ground temperature would increase, air expands and rises, and a long-lasting low-pressure area would be formed above ground. As wind blows from the high-pressure area to low pressure area, monsoon winds will travel from the higher pressure areas in the Indian Ocean, Hainan Province in China and Northern Australia to the low-pressure areas in the inland of China. The humid monsoon winds bring a lot of precipitation to the Greater Bay Area during this time, which marks the wet season of the region. The Greater Bay Area is often influenced by tropical cyclones in summer too. Tropical cyclones, also known as

"typhoons" in Hong Kong, are strong low-pressure systems that are mostly formed in the Northwest Pacific Ocean of the east of the Philippines. The Greater Bay Area is usually affected by tropical cyclones during the period from April to October, but most frequently in August and September. As tropical cyclone gradually approaches the Greater Bay Area, the weather in the area will become very hot and humid. As tropical cyclone gets close, the weather of the area gets worse and heavy rainstorms occur. As the cyclone leaves, the weather of the area will resume normal. The Greater Bay Area was affected by 5 typhoons (Nuri, Sinlaku, Higos, Nangka, Saudel) in 2020.

Autumn is a transitional season in the Greater Bay Area between September and November. Air pressure increases and temperature drops from above 30^{o}C in summer to around 20 ^{o}C. Summer monsoon starts to dissipate, which leads to the decrease in humidity. Easterly wind is the prevailing wind in this season. In autumn, tropical cyclones in South China Sea mostly make landfall in Western Guangdong or Hainan Province, an example is the tropical storm Francisco that occurred in September 2007.

In winter, the water in the South China Sea gradually gets cold. As cold continental anticyclone extends eastward and the easterly winds becomes stronger, the weather of the Greater Bay Area in winter is generally cold, humid and cloudy. The Greater Bay Area is affected by winter monsoons from December to February. The differences in heating and cooling rates between the land and the sea is the major contributing factor to the formation of monsoon. In winter, temperature in the inlands of China is lower, forming a high-pressure centre. On the other hand, as ocean waters have a relatively higher temperature due to its lower rate of cooling, a low-pressure area would be formed above the ocean. In the same period of time, it is summer in the southern hemisphere, which the region has a higher temperature, and can lead to the formation of a low-pressure area. Wind blows out from the high-pressure centre clockwise and forms offshore winter monsoons. Sham Fu Cheung（2010）indicated that Coriolis force from the Earth's rotation can change the direction of winds. In the northern hemisphere, Coriolis force would cause air to deflect to the right when air travels outward from high-pressure centre, forming clockwise rotations. In the southern hemisphere, the opposite happens. Coriolis force would cause air to deflect to the left when air travels outward from high-pressure centre, forming anti-clockwise rotations. Therefore, offshore winds in winter are northerly winds or northeasterly winds. However, northeast monsoons in the continent are not stable, their strength

may vary, and they generally last for a week, reflecting the fluctuations of the Siberian Anticyclone. Continental cold air usually extends to the southern parts by the end of January or the beginning of February, therefore, it is also the coldest period in the Mainland (including the Greater Bay Area).

3 Climatic characteristics

Climate refers to the general atmospheric conditions of a certain place over a long period of time. It usually requires long-term observations and records to describe the climate of a place. A common practice is to calculate the averages of various parameters over a 30-year period, which would result in more stable statistics. The World Meteorological Organisation recommends that observations in the period of 1961-1990 should be used as the global standard.

3.1 Temperature

The Greater Bay Area generally has a relatively high temperature. In 1961-2018, the annual mean temperature of the Greater Bay Area was around 22.5℃, and the maximum temperature was around 34.9-39.6℃. According to the climate statistics in 1961-2018, annual mean temperature in the Greater Bay Area showed an increasing trend. According to the "Guangdong-Hong Kong-Macao Greater Bay Area Climate Bulletin 2020" jointly published by the Guangdong Meteorological Service, Macao Meteorological and Geophysical Bureau and Hong Kong Observatory in 2021, the mean temperature of the Greater Bay Area in 2020 was 23.2℃, there was a total of 29.9 hot days, which the two indexes were both at their highest since 1961. In late June to September, under the influence of the western North Pacific Subtropical High, the weather in the Greater Bay Area was hot with little rain or thunderstorm. In late August to the beginning of September, temperature in the Greater Bay Area was particularly high, the maximum temperature in most areas was around 35-37.4℃. Cities in the south, including Hong Kong SAR, Macao SAR, Shenzhen, Zhongshan and Zhuhai had the highest temperature records.

3.2 Precipitation

The Greater Bay Area has a warm and rainy climate, the annual mean precipitation in 1981-2010 was around 1,900mm（Wu Hongyu, Zhai Zhihong, Zhang Yu, 2019）. Precipitation of the region mostly occur during March to September. Rainfall in the wet season accounts for 70% to 80% of the annual total precipitation and rainstorms are mostly severe. The distribution of annual precipitation varies within the region and annual changes exist, and there is a clear trend that the eastern areas receive more rainfall and the western areas receive less. In general, coastal cities have higher precipitation than cities further away from the coast, for example, Hong Kong and Shenzhen have higher annual precipitation than Zhaoqing and Foshan. Due to the influence of monsoon systems, wet seasons in the Greater Bay Area come in two periods: (1) from March to June, where precipitation mainly originates from weak cold fronts and troughs (including Meiyu trough) and (2) from July to September, where precipitation is mostly brought by tropical cyclones.

4 Conclusion

Under the influence of subtropical monsoon climates, the Greater Bay Area has a warm climate with sufficient rainfall, which makes it one of the most resourceful and liveable region in China in terms of sunlight, heat and water resources. However, climate change induced by rapid industrialisation and urbanisation has brought various problems and threats, including regional warming, sea level rise, and flooding. While the occurrence of some climatic hazards (e.g., tropical cyclone and flooding) are also partly associated to the geographical location of the area, human activities most certainly still play an important role given the increasing prevalence of such hazards. The establishment of the Greater Bay Area allows further cooperation between Guangdong, Hong Kong and Macao in weather monitoring. Currently, the Greater Pearl River Delta Weather Website has been developed. The website integrates weather information of the three places, reports weather conditions, forecast and warnings of the cities, and provides quality and reliable weather services to people in the Greater Bay Area. As the Greater Bay Area develops, more cooperation between the Guangdong, Hong Kong and Macao on weather monitoring, environmental protection and meteorological hazard prevention expected in the future.

Table of figures

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