Extreme Temperature Rise in East Asia Cities

Greenpeace East Asia analyzed temperature records for the most populous cities in China Mainland, Korea and Japan. Researchers found that the annual number of extreme hot days (above 33C) had increased significantly since 1961. In addition, in recent years summer has arrived earlier in more than 80% of cities studied.

Extreme temperatures are a threat to human health, agriculture and ecosystems. Between 2000 and 2018, heat-related deaths in people over the age of 65 increased by 54% worldwide, with Japan and eastern China particularly affected.[1] Recent research projects that by 2100 summer in the Northern Hemisphere may last nearly half the year under a business as usual emissions trajectory.[2]

It is urgent that governments and corporations take faster and more ambitious climate action. We ask governments to deliver climate plans with firm and achievable solutions, including ending financing of the fossil fuel industry and switching to 100% renewable energy as quickly as possible.

I. Early Arrival of Summer

An analysis of 57 of the most populous cities in China Mainland, Korea and Japan finds that the first day of summer is arriving earlier in 48 out of the 57 cities.

This study adopts a threshold of 30C to define “hot days” and 33C to define “extreme hot days.” In some cases 35C is also used as a benchmark.

China Mainland

Researchers analyzed the 30 most populous cities in China Mainland using publicly available data from the Global Historical Climatology Network (GHCN). Two cities with insufficient data were excluded from the results (Kunming, Xi’an).

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[1] Watts, N., Amann, M., Arnell, N., et al., 2020, The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises, The Lancet, Vol. 397: pp.129-170 DOI:https://doi.org/10.1016/S0140-6736(20)32290-X

[2] Warming, Geophysical Research Letters, Vol.48(6): e2020GL091753 DOI: 10.1029/2020GL091753 Wang, J., Guan, Y., Wu L., et al., 2021, Changing lengths of the four seasons by global

In 24 out of the 28 Chinese cities studied, the first hot day of the year (30C) arrived earlier for the period 2001-2020 compared to the previous two decades. Changsha saw the most dramatic shift, with the first hot day of the year arriving on average more than three weeks earlier than the baseline period. In Chongqing and Wuxi the first hot day shifted forward by nearly two weeks.

In Shanghai, the first hot day arrived 12.0 days earlier than the previous 20-year period (average April 30, compared to May 12), while in Beijing it arrived an average of 4.7 days earlier.

Japan

Researchers analyzed the 21 most populous cities in Japan using data from the Japan Meteorological Agency.

Hot weather (30 C) has begun to arrive earlier in the year in 18 out of Japan's 21 most populous cities. In Sapporo, the first hot day on average occurred 23.1 days earlier during 2001-2020 compared to the previous 20-year period. In Sendai, Kitakyushu, Chiba and Hamamatsu the first hot days also arrived more than two weeks earlier.

In Tokyo, the first hot day of the year arrived on average 10.9 days earlier when comparing the periods 1981-2000 (June 20) and 2001-2020 (June 9).

This trend is not significant in only 3 out of 21 cities studied: Shizuoka, Kumamoto and Kobe.

Korea

Researchers analyzed the 8 most populous cities in Korea using data from the Korea Meteorological Administration. Hot days (30C) are arriving sooner in 6 of 8 Korean cities studied.

In Seoul, the first hot day of the year arrived on average 10.6 days earlier during the period 2001-2020 compared to the previous 20-year period.

Gwangju saw the most dramatic shift of all Korean cities studied, with the first hot day arriving 12.7 days earlier for the period 2001-2020 compared to the baseline. In Busan, Seoul and Suwon, the first hot day occurred more than one week earlier for the period 2001-2020 compared to the previous two decades.

Location	Total Cities Researched	Cities with Early Arrival of Hot Weather (30C)
China Mainland	28	24
Japan	21	18
Korea	8	6
Total	**57**	**48**

Data sources: NOAA-GHCN, JMA, KMA, daily temperature data
**For Chinese cities Dalian and Qingdao, Tmax data is not complete for 1-2 years. Researchers eliminated the years with incomplete data and calculated the average for the rest of the years.*

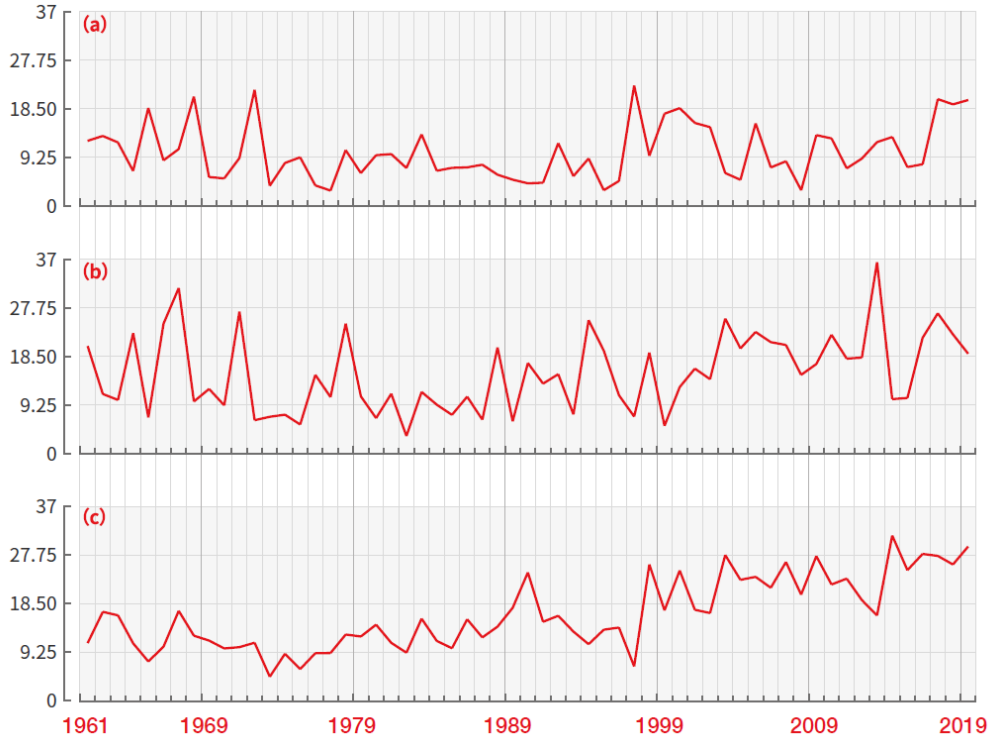
II. Rise in Frequency of Extreme Heat

The number of extreme hot days is on the rise across East Asia, in some cases more than doubling since the 1960s.

China Mainland

The major metropolitan areas of Beijing, Shanghai, and Guangzhou-Shenzhen have experienced heatwaves (daily maximum temperature of over 35C for at least 3 days) with increasing frequency and severity in recent decades, especially since the 1990s.

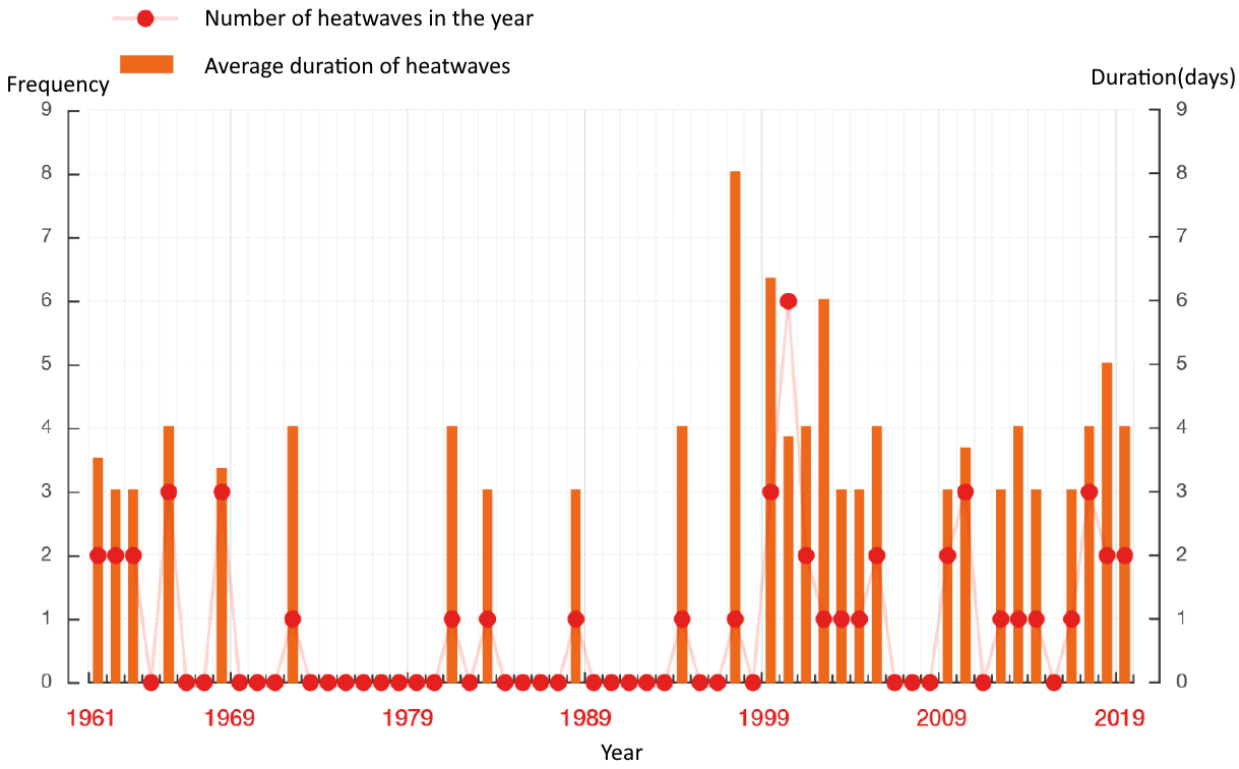
Since 1961, the number of 35C days in the Beijing-Tianjin-Hebei region has been on the rise, increasing significantly since the 1990s. Between 1998-2019 the average number of extreme hot days (35C) reached 23.7 days per year, compared to an average of 16.5 days for the period 1961 to 2019.



The number of extreme hot days (35C) in the Beijing-Tianjin-Hebei region (a), the Yangtze River Delta region (b) and Guangdong Province (c) during the period 1961-2020

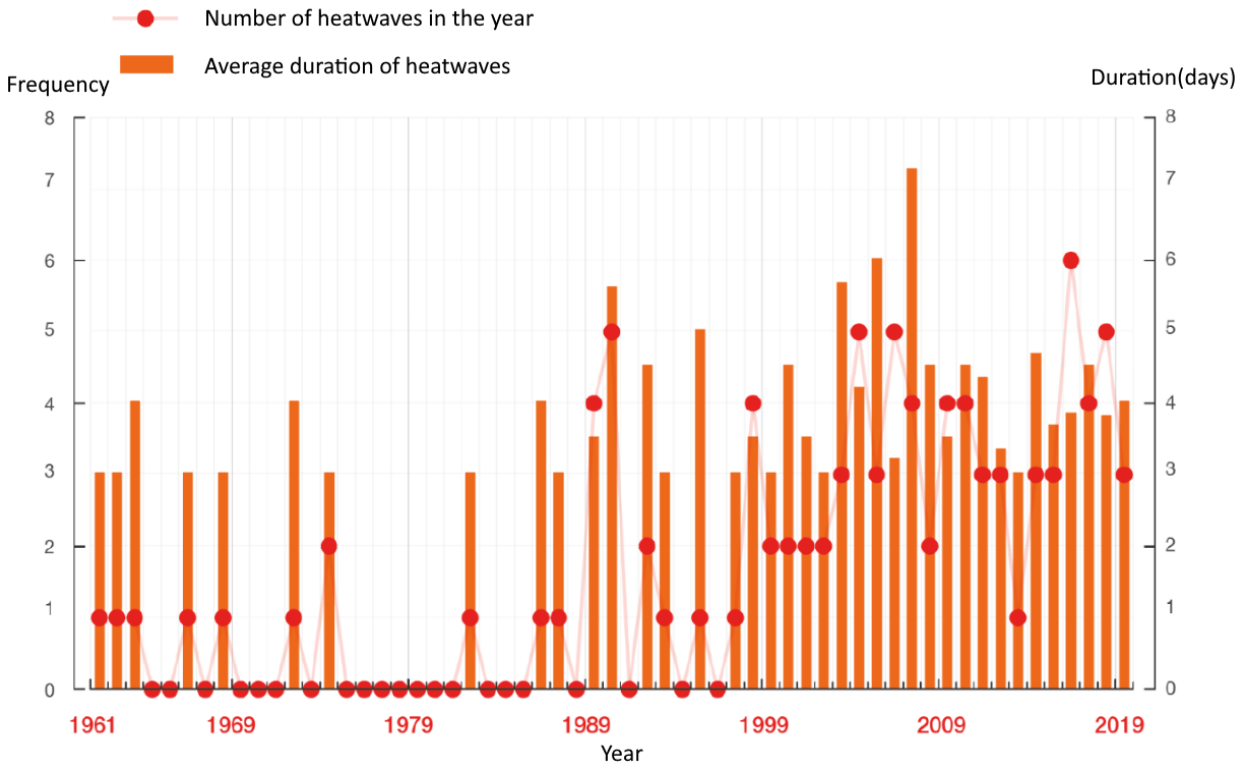
Since 2000, the frequency of heat waves in Beijing has been nearly triple (average 1.45/year) that of the previous 40-year period (.54/year). In addition, the duration of heatwaves has also increased, with the three longest heat waves occurring in 1997,

1999 and 2002.



The number of heatwaves (red dots) and average heat wave duration (orange bars) recorded at the Beijing weather station during the period 1961-2020

Between 1961 and 2019, a total of 98 heat waves have taken place in Guangzhou, with 74% of the total heat wave events occurring after 1998. The duration of heatwaves has also increased.

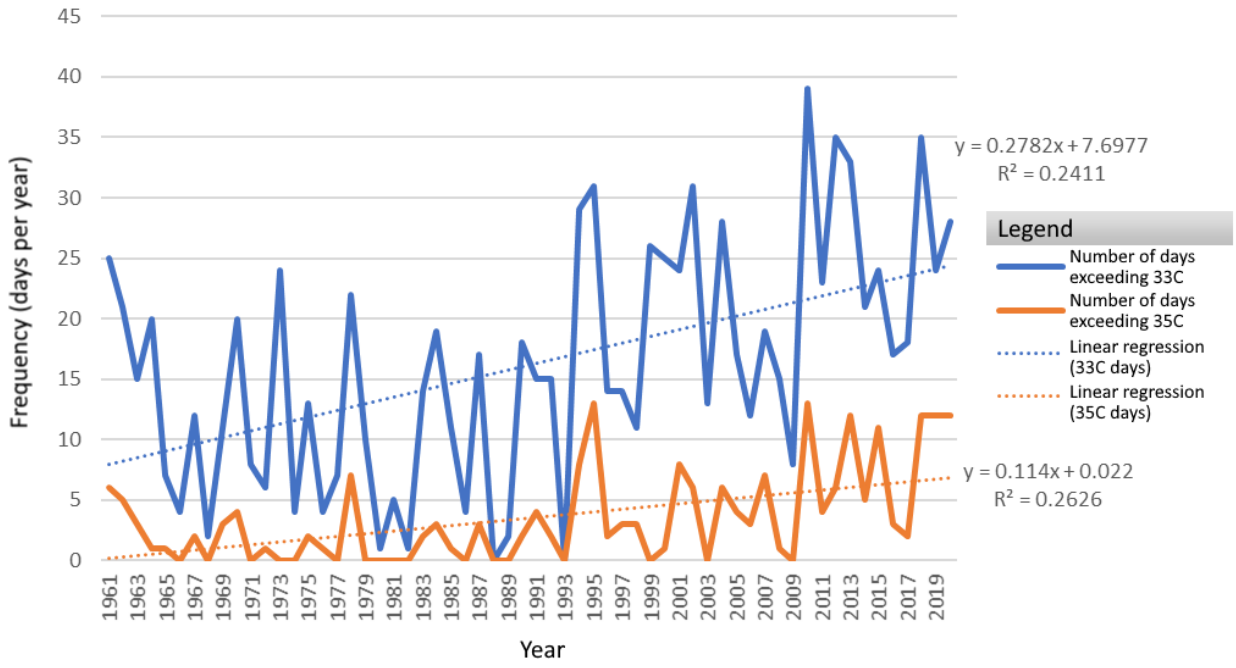


The number of heatwaves (red dots) and average heat wave duration (orange bars) recorded at the Guangzhou weather station during the period 1961-2020

Japan

In 17 out of the 21 cities, the number of extreme hot days per year (33C) has increased significantly, especially since the 1980s.

In Tokyo, the number of extreme hot days has increased at a rate of nearly 3 days per decade since 1961. In the 1960s, the temperature in Tokyo reached 33C on average 13.0 days per year, while for the period 2011-2020 that number had more than doubled to 26.9.



The increasing number of 33C (blue line) and 35C (orange line) days per year in Tokyo from 1961-2020

In Sakai the number of extreme hot days has increased at an astonishing rate of approximately 8 days per decade since the late 1970s. Days when temperatures reach 35C or higher have increased by an average of 4.7 days per decade. The average number of hot days per year has shot up from 14.9 in the 1980s to 42.6 in the 2010s.

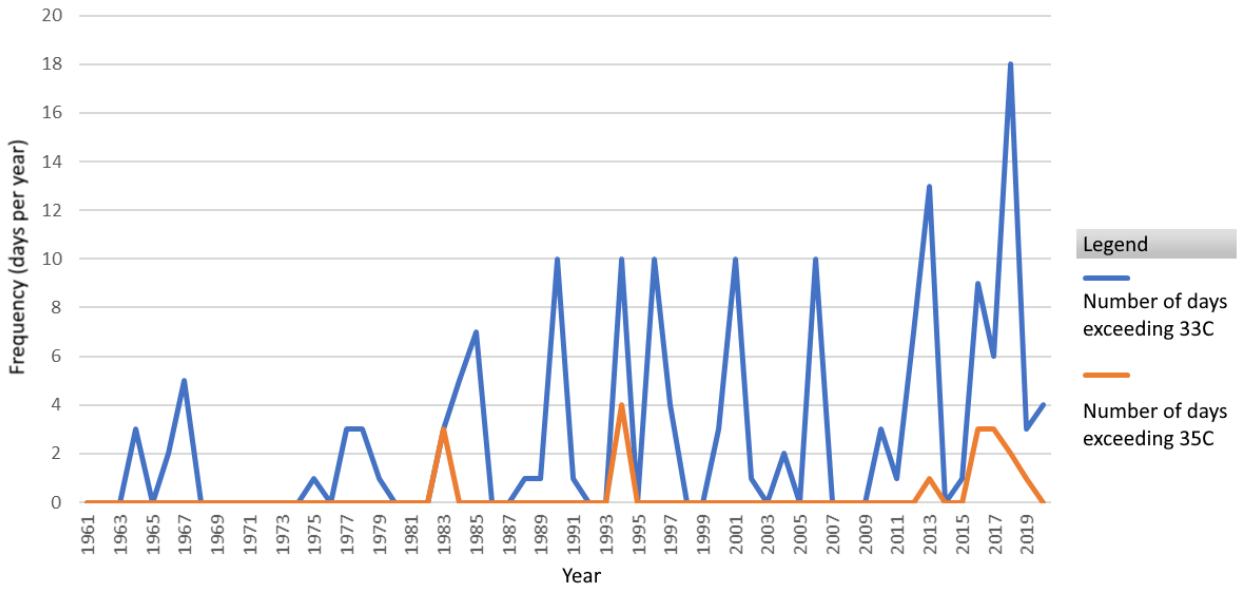
In Saitama, where rapid urbanization is taking place, the number of extreme hot days has been increasing at a rate of 5.1 days per decade since the 1980s. Hiroshima and Kitakyushu have seen average increases of close to 6 hot days per decade over the same period.

In Sapporo, the number of days when temperatures reached 30C has more than doubled from 5.4 days per year in the 1960s to 12.2 per year between 2010 and 2020.

Korea

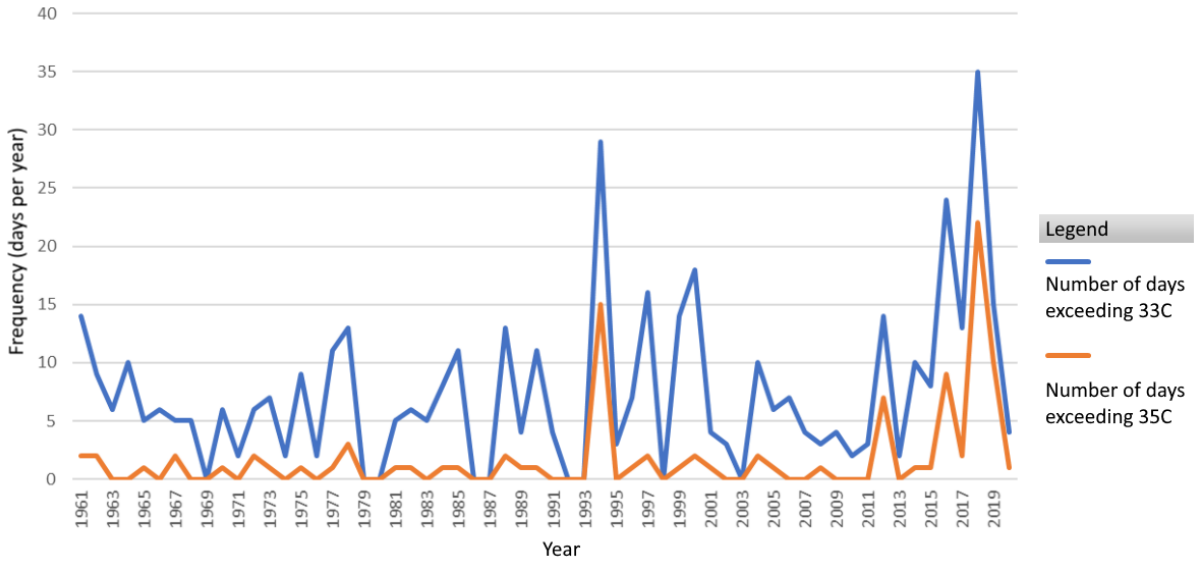
For all Korean cities studied, the most recent decade saw the highest number of 35C days over the past 60 years.

In Busan, the number of annual 33C days did not exceed 10 for the period 1961-2010. However in 2013, it reached 13 days, and in 2018 skyrocketed to a peak of 18 days.

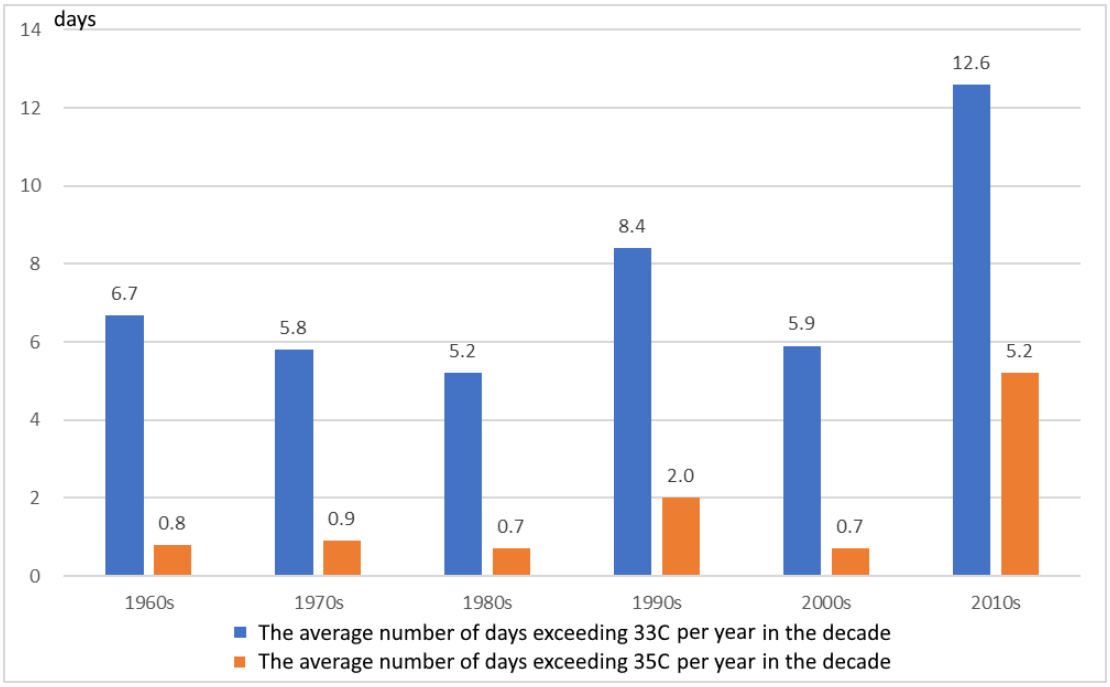


The number of extreme hot days with maximum daily temperature of 33C (blue line) and 35C (orange line) throughout the period 1961-2020 in Busan

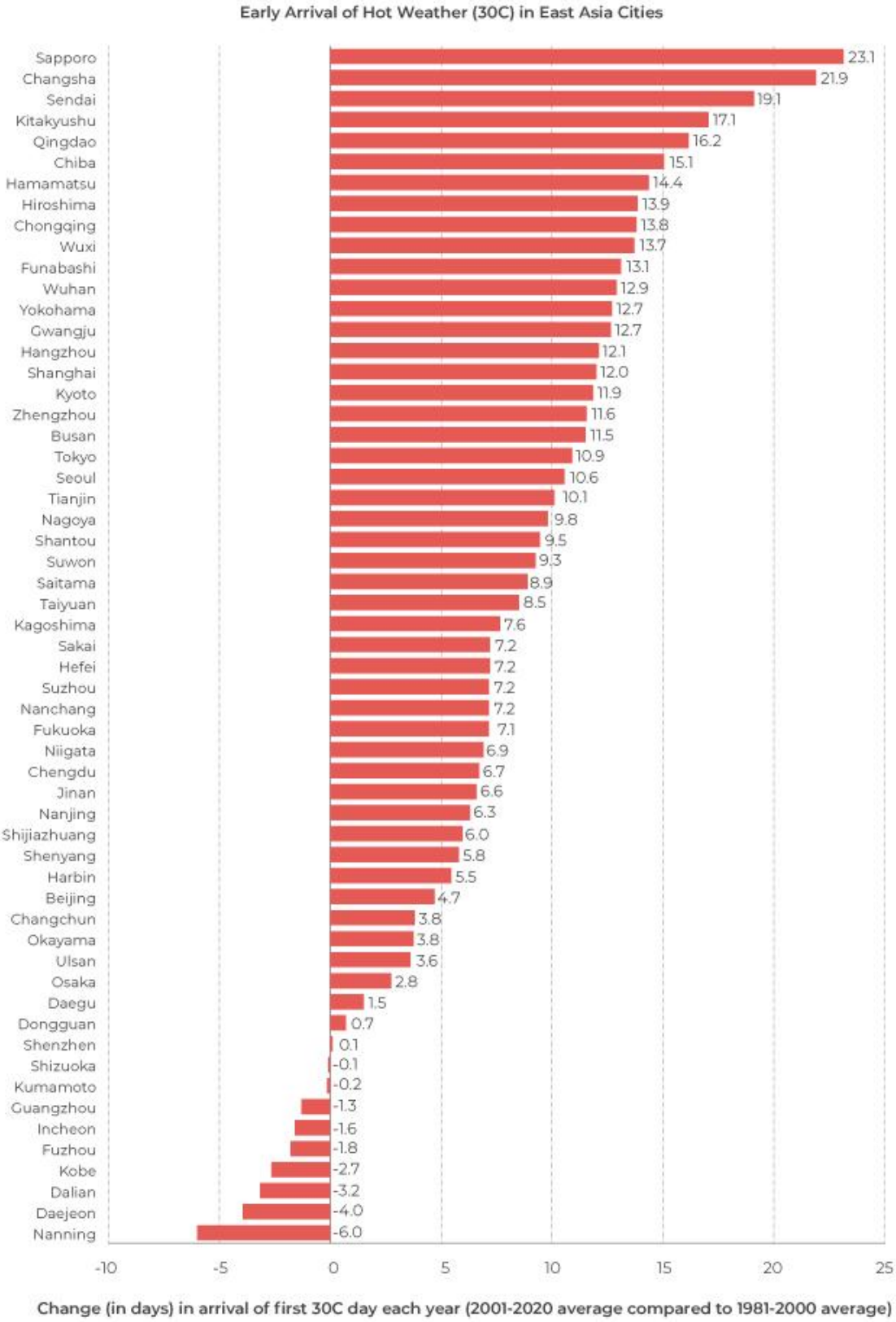
Likewise, in Seoul the average number of 33C days exceeded 12 for the period 2010-2019, more than double the average for 1961-1990.



The number of extreme hot days with maximum daily temperature of 33C (blue line) and 35C (orange line) throughout the research period 1961-2020 in Seoul



The average number of extreme hot days during each decade in Seoul


Early Arrival of Hot Weather (30C) in East Asia Cities
Sapporo 23.1
Changsha 21.9
Sendai 19.1
Kitakyushu 17.1
Qingdao 16.2
Chiba 15.1
Hamamatsu 14.4
Hiroshima 13.9
Chongqing 13.8
Wuxi 13.7
Funabashi 13.1
Wuhan 12.9
Yokohama 12.7
Gwangju 12.7
Hangzhou 12.1
Shanghai 12.0
Kyoto 11.9
Zhengzhou 11.6
Busan 11.5
Tokyo 10.9
Seoul 10.6
Tianjin 10.1
Nagoya 9.8
Shantou 9.5
Suwon 9.3
Saitama 8.9
Taiyuan 8.5
Kagoshima 7.6
Sakai 7.2
Hefei 7.2
Suzhou 7.2
Nanchang 7.2
Fukuoka 7.1
Niigata 6.9
Chengdu 6.7
Jinan 6.6
Nanjing 6.3
Shijiazhuang 6.0
Shenyang 5.8
Harbin 5.5
Beijing 4.7
Changchun 3.8
Okayama 3.8
Ulsan 3.6
Osaka 2.8
Daegu 1.5
Dongguan 0.7
Shenzhen 0.1
Shizuoka -0.1
Kumamoto -0.2
Guangzhou -1.3
Incheon -1.6
Fuzhou -1.8
Kobe -2.7
Dalian -3.2
Daejeon -4.0
Nanning -6.0
-10
-5
0
5
10
15
20
25
Change (in days) in arrival of first 30C day each year (2001-2020 average compared to 1981-2000 average)