

The Effect of Temperature upon Transmission of COVID-19: Australia and Egypt Case Studies, Jan-March 2020

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ABSTRACT

The paper attempted to test the results of previous Chinese studies, which recognized that the most appropriate average temperature for virus activity and transmission ranges between 13-24 °C, in reality through maps of the monthly temperature average during the period from Jan to March 2020 through case studies of Australia and Egypt because of the availability of climatic data and numbers of confirmed cases. The study tried to predict the future of the virus spread during the upcoming seasons through cartographic methods. The study reached, through cartographic analysis, to confirm the inverse correlation relationship between temperature and increase in the number of confirmed cases in Australia during the month of March, and also the decrease in the number of cases in Egypt in the same month. [Bul. Soc. Géog. d'Égypte, 2021, 94: 44-68]

Key Words: COVID-19, Transmission, Temperature, Australia, Egypt.

1. Introduction

This paper is based on previous studies on the relationship between climate and the spread of germs and viruses, and on the results of contemporary studies on the existence of a correlation between air temperature and Covid-19 activity and transmission, Some of these studies were carried out in China, especially in the period before the Chinese government took measures to combat this global pandemic. These studies confirmed that the most appropriate average temperature for virus activity and transmission ranges between 13-24 ° C. Australia and Egypt are models to confirm the relationship between temperature and coronavirus activity and spread.

Research Objectives:

To investigate air temperature for incidence and spread of Covid-19 infection, to predict the epidemiology of the infectious disease, and to provide a scientific basis for prevention and control measures against the new disease.

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2. Material and Methods

The paper attempted to test the results of previous Chinese studies, which recognized that the most appropriate average temperature for virus activity and transmission ranges between 13-24 °C, in reality through maps of the monthly temperature average during the period from Jan to March 2020 through case studies of Australia and Egypt because of the availability of climatic data and numbers of confirmed cases. The study tried to predict the future of the virus spread during the upcoming seasons through cartographic methods, Mean Temperature maps were obtained from Australia's national weather, climate and water agency, The Bureau of Meteorology, USGS, Early Warning and Environmental Monitoring Program, and ACC weather. Confirmed cases numbers were gathered from Australian Government Health Department, and WHO. The case studies of Egypt and Australia were chosen as two models for different climates, and for comparison between two countries, one of which is in the northern hemisphere (Egypt), and the other is located in the southern hemisphere (Australia).

3. Discussion

Several old previous studies indicated that there is a relationship between climate and the spread of certain types of germs, and viruses that cause diseases, and this is especially true for malaria, which only spreads under certain weather conditions in terms of temperature and humidity. There is no doubt that there are a large number of diseases, the spread of which is associated with certain seasons. It was also noticed that the common flu increases in cold shows than in hot tropical shows (Fayed, 1989). Also, Oliver notes that most of the deaths that occurred in England and Wales due to heart disease and respiratory disease occurred in the winter months between November and March (Oliver, 1981).

There is a relationship between air humidity and the life of bacteria and viruses. The influenza virus dies more quickly in conditions of high humidity accompanied by fast moving air, so the winter months in which humidity decreases and the speed of air movement decreases are more appropriate for the spread of respiratory infections (Toureh, 1995). It was also found that the TB germ, if exposed to sunlight, stops its activity within one hour. Whereas in the normal light, it remains active between 6-24 hours, and in the dark, it lives in a state of activity between two and eighteen months, so chest diseases hospitals must be established in sunny areas (Fayed, 1989).

A severe respiratory disease was recently reported in Wuhan, Hubei province, China. As of 25 January 2020, at least 1,975 cases had been

reported since the first patient was hospitalized on 12 December 2019, Epidemiological investigations have suggested that the outbreak was associated with a seafood market in Wuhan. Phylogenetic analysis of the complete viral genome revealed that the virus was most closely related (89.1% nucleotide similarity) to a group of SARS-like coronaviruses (genus Betacoronavirus, subgenus Sarbecovirus) that had previously been found in bats in China. The sequences are almost identical and share 79.6% sequence identity to SARS-CoV. Furthermore, Researchers show that 2019-nCoV is 96% identical at the whole-genome level to a bat coronavirus. This outbreak highlights the ongoing ability of viral spill-over from animals to cause severe disease in humans (Wu et al., March 2020). It appears that most of the early cases had contact history with the original seafood market (Zhou et al., 2020).

Compared to the 2002/2003 SARS-CoV and the 2012–2014 MERS-CoV (Middle East Respiratory Syndrome-related coronavirus), the COVID-19 coronavirus spread strikingly fast. While MERS took about two and half years to infect 1000 people, and SARS took roughly 4 months, the novel SARS-CoV-2 (COVID-19) reached that figure in just 48 days. On 30 January 2020, the World Health Organization (WHO) declared that the new SARS-CoV-2 coronavirus outbreak constitutes a Public Health Emergency of International Concern (PHEIC) (Boulos & Geraghty, 2020). As of 2 March 2020, more than 89,000 COVID-19 cases have been reported globally, from all provinces of China and 66 countries globally. Global outbreaks of COVID-19 have posed major obstacles to public health and the world economy (Jingyuan, 2020). As of 30 March 2020, 720,000 cases had been reported globally including 177 countries about 34,000 of them died (www.accuweather.com, March 2020). An increase of 631,000 cases over 28 days, with an average of about 22550 cases per day.

Multiple countries have confirmed travel-associated cases, including Australia, Cambodia, Canada, France, Germany, Japan, Nepal, Singapore, South Korea, Taiwan, Thailand, United Arab Emirates, United States, and Vietnam. Vietnam identified the first human-to-human transmission outside China (Alexandra et al., 2020). As of 30 March 2020 The highest cases were recorded in United States of America, Italy, and China.

Bu et al. (2020) find that the suitable temperature range for COVID-19 survival is (13–24 °C), among which 19°C lasting about 60 days is conducive to the spread between the vector and humans; the humidity range is 50–80%, of which about 75% humidity is conducive to the survival of the coronavirus; the suitable precipitation range is below 30 mm/month. The

prediction results show that with the approach of spring, the temperature in north China gradually rises, and the coronavirus spreads to middle and high latitudes along the temperature line of 13-19 °C (Bu et al., 2020).

Wang et al. (2020) find that after estimating the serial interval of COVID-19 from 105 pairs of the virus carrier and the infected, they calculate the daily effective reproductive number, R , for each of all 100 Chinese cities with more than 40 cases. Using the daily R values from January 21 to 23, 2020 as proxies of non-intervened transmission intensity, they find, under a linear regression framework for 100 Chinese cities, high temperature and high relative humidity significantly reduce the transmission of COVID-19, respectively, even after controlling for population density and GDP per capita of cities. One degree Celsius increase in temperature and one percent increase in relative humidity lower R by 0.0383 and 0.0224, respectively (Wang, 2020).

Comparison of meteorological conditions of the onset of 2019-nCoV pneumonia in 2019 and SARS pneumonia in 2003, from October to November 2019 in Wuhan, the mean temperature in Wuhan dropped from 18.28 to 13.43 °C. Humidity remained between 73.12 and 77.58%, and the first few cases of the 2019-nCoV pneumonia occurred in early December. The meteorological conditions significantly overlapped with those of SARS onset in Guangzhou. In the winter of 2002, the temperature was between 13.85 to 15.85 °C, and humidity kept between 69.05 and 78.91% in Guangzhou. Considering the data above including 2019-nCoV in Wuhan, SARS coronavirus in Guangzhou and Beijing, they speculate that a meteorological condition with temperature between 13-19 °C and humidity between 50 and 80% is suitable for the survival and transmission of the coronavirus. (Bu et al, 2020) Lower rainfall and therefore reduced relative humidity provide a good opportunity for the transmission of respiratory pathogen infections, including coronavirus (Bi et al., 2007).

3.1 The Case Study of Australia, 2020:

The validity of these results has also been demonstrated through the case study of Australia. In Australia, the first case appeared in Melbourne on January 19 for a Chinese person coming from Guangzhou, and the numbers during January and February were very few (the southern summer months) with 9 cases recorded in January, and only 12 cases in February.

Applying to Australia, we find that through Figure (1) that shows the mean temperature in January, Figure (2) that shows the mean temperature in February, Figure (3) that shows the mean temperatures in March, Figure (4) shows the distribution of Corona cases in Australia in March, Figure (5)

shows Confirmed Cases of Coronavirus (COVID-19) in Australia, And figure (6) shows how often the number of confirmed cases in Australia doubles through March . All these figures show the speed of the virus and its relationship to temperature. Here are the details:

3.1.1 During the Summer:

Looking at Figure (1), it is noted that the area which covered by average temperatures 12-24 °C in January (the middle month in the southern summer that runs from December to February) was a small strip in southern Australia, In this region the city of Melbourne is located, which is the city that had the first cases of infection in Australia, and which located in the temperature range 18-21 °C.

In February (Figure 2) the conditions remained the same with a small increase in the area of this southern strip of the country, which is located in a temperature range less than 24 °C, but with a noticeable increase in the area of land which is located in the temperature ranges from 24-27 and from 27-30 °C. This was likely to have played a role in slowing the natural spread of the virus.

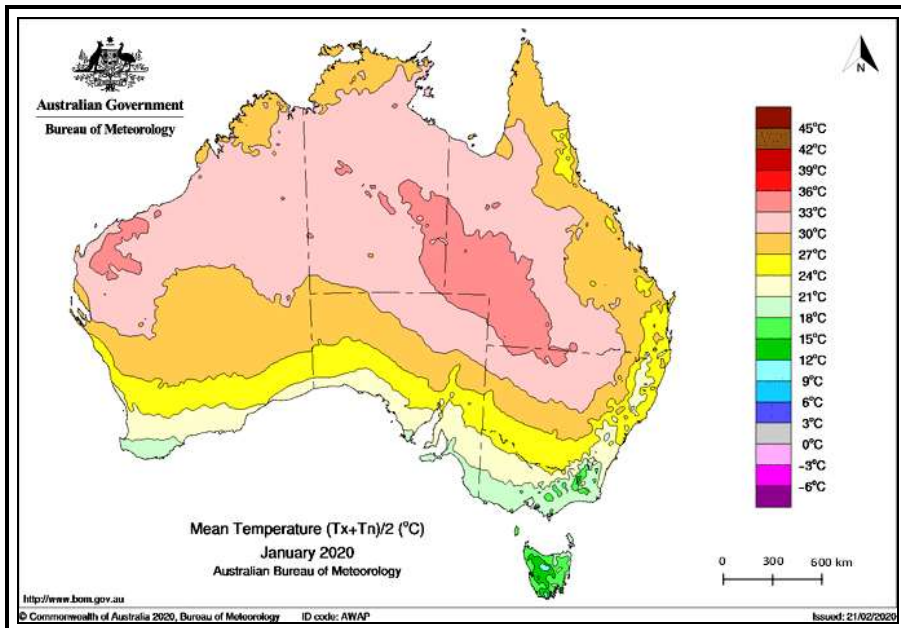


Figure 1. Mean Temperature, January 2020, Australia.

Source: <http://www.bom.gov.au>

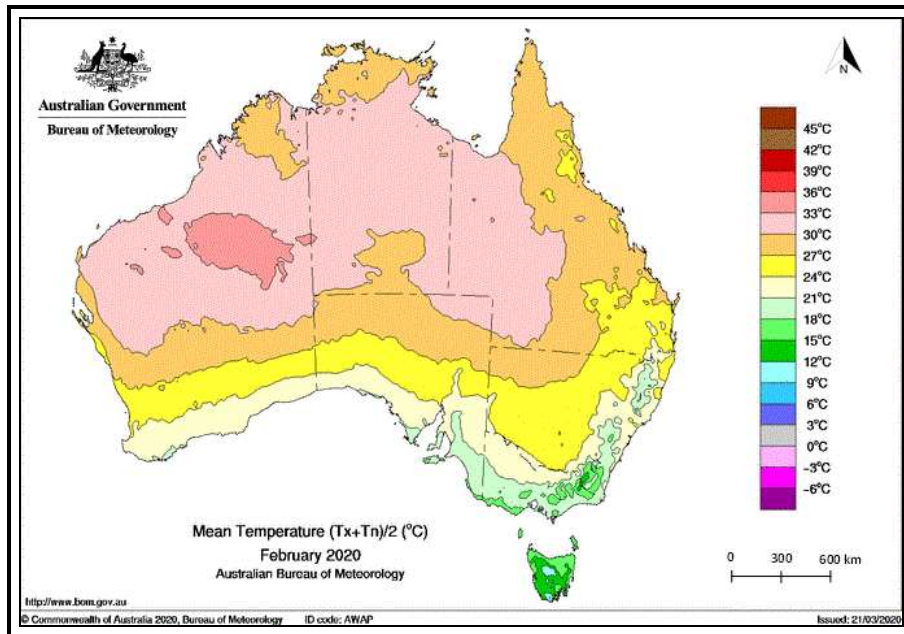


Figure 2. Mean Temperatures, February 2020, Australia.

Source: <http://www.bom.gov.au>

3.1.2 During the Autumn:

However, the matter differed a lot in March (Beginning of the southern Autumn, which extends from the beginning of March to the end of May), as it is observed from Figures (3) and (4):

- All the cities and states where many infections occurred during March occurred in the areas where the average mean daily temperature Decreased below 24 °C
- That areas became represents about a quarter of the Australian lands, and it extended in a form of a strip from east to west in south of Australia, With exceptions, there were very few areas with average less than 13 °C.
- It includes the cities of Sydney, Melbourne, Brisbane, Adelaide, and Berth, with the exception of Darwin, which is located in north of Australia. Note that they are millions cities and are the largest cities in terms of population size in Australia ,except Darwin, This also plays a role in the transmission of infection from one person to another.

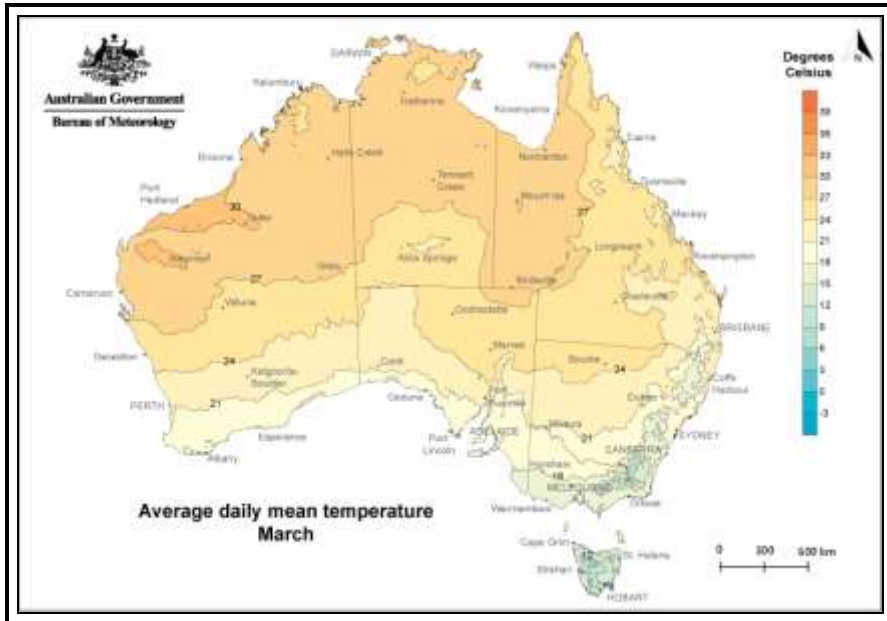


Figure 3. March Average daily Mean Temperatures, Australia, based on a standard 30-year climatology 1961-1990.

Source: <http://www.bom.gov.au>



Figure 4. Confirmed Cases of Coronavirus (COVID-19) in Australian cities.

Source: <https://www.accuweather.com/en/eg/national/covid-19, 3/29/2020>.

This thermal range (12-24 °C) is covered:

- Most of the lands of New South Wales state, which recorded the highest number of cases of infection with coronavirus during March and came first in terms of the number of confirmed cases (2032 cases) (<https://www.health.gov.au-3/31/2020>).
- All the lands of the state of Victoria, which came second in terms of the number of confirmed cases (917 cases).
- Southeast Queensland, which ranked third (743 cases), and wherever Brisbane is located where a large number of cases are recorded.
- About a third of the area of Western Australia, in which the city of Perth is located in the southwest of the state, located at the temperature line 21°C. It came in fourth place (364 cases).
- Half of the area of the state of south Australia, which came in fifth place (337 cases).

Note that the northern province, which located completely in a temperature range greater than 24 °C has recorded the lowest number of confirmed cases (only 16 cases), also we find that the state of Tasmania, the island state, most of its lands located in a temperature zone less than 12°C, has registered 68 cases.

Accordingly, if we exclude the effect of other factors, Australia is a model to confirm the relationship between temperature and coronavirus activity and spread, In March, it became clear that the areas most affected and spread by the virus are the regions with an average temperature of 12-24 °C. And the northern province with the average temperature above 24°C (in the far north) and the state of Tasmania, in which the average temperature located below 12°C in the far south, Both of them scored very few cases.

Perhaps a simple presentation of the numbers of infections during March may explain the effect of lower temperatures during this month on the speed of transmission of the virus, in March there were large consecutive numbers, as shown in Figure (5). The numbers recorded during this month reached to 4087 cases until 3/28/2020. The new cases remained less than 25 cases per day from 1-15 March, then became within 50 cases per day from 12 to 15 March, from 80 to 150 cases per day from 16 to 19 March, from 150 to 300 cases in the period 20-22 March, from 300 to 400 cases daily during the period from March 23-27, then the number jumped to 459 cases on March 28. Figure (6) shows how often the number of confirmed cases in Australia doubles. It's a key measure that shows how quickly the virus is spreading throw Jan-March 2020, it shows that the rate of multiplication of numbers was almost every 3 days during March.

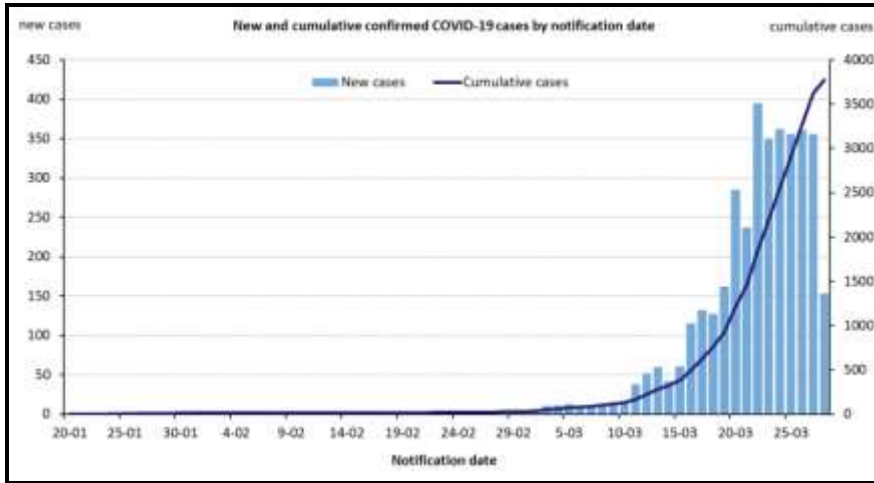


Figure 5. New and Confirmed Cases of Coronavirus (COVID-19) in Australia Jan-March 2020.

Source: <https://www.abc.net.au/>

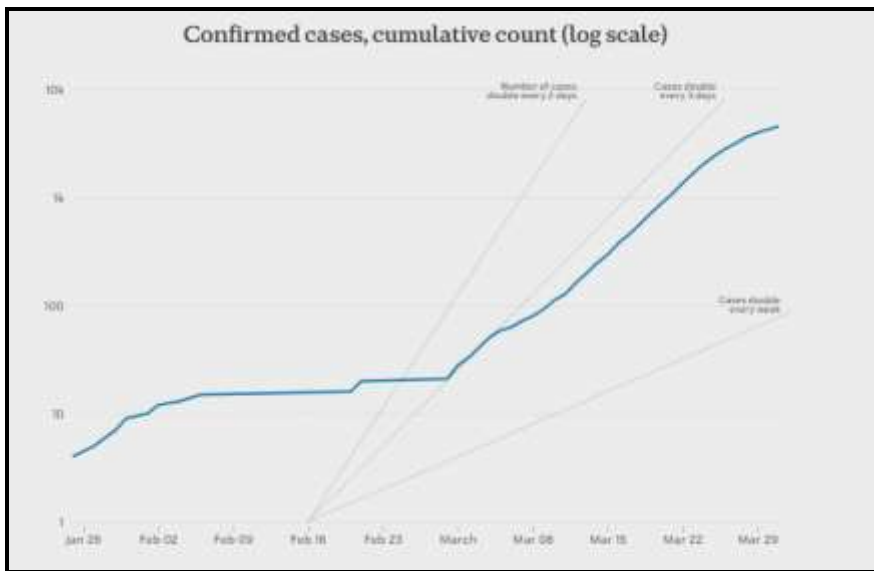


Figure 6. Developing of confirmed cases in Australia in January-March.

Source: <https://www.abc.net.au/>

Australia may face a major crisis during the rest of the autumn months (April and May). As can be seen from Figure (7), **In April** about 75% of Australia’s land will be located between 12-24 °C heat lines. While **in May** most of Australia's lands will become between 12-24 °C heat lines, with the exception of its northern fringes, where the average temperature rises above 24 °C, and its

southeastern side, where the temperature will drop below 12 °C, which also means that Coronavirus activity can be disabled in these areas.

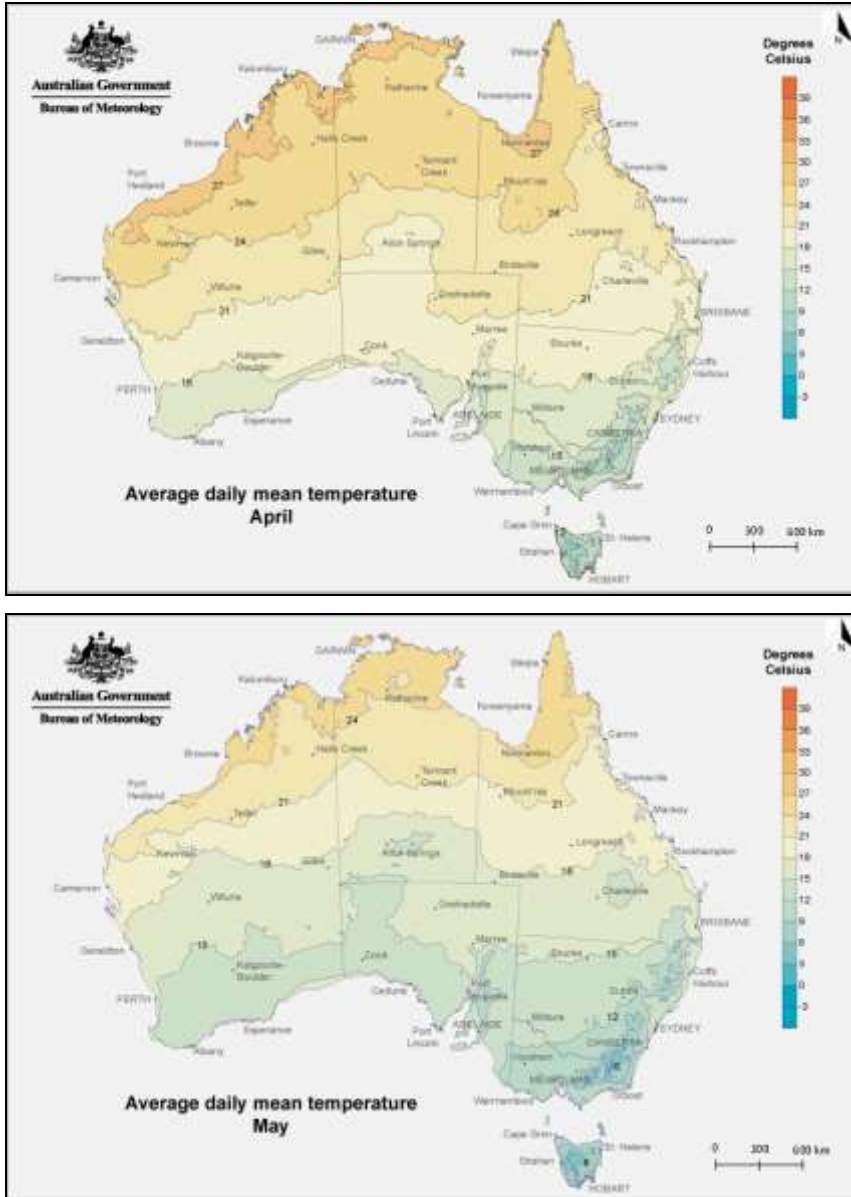


Figure 7. Average daily Mean Temperatures, Australia, April & May, based on a standard 30-year climatology 1961-1990.

Source: <http://www.bom.gov.au>

3.1.3 During the Winter:

The risk is expected to increase in the southern winter months (June - July - August) in the central and northern regions, where the average daily temperature ranges between 12-24 °C. While the temperature of the south will be less than 12 degrees Celsius, that is, the risk will be relatively less for these areas.

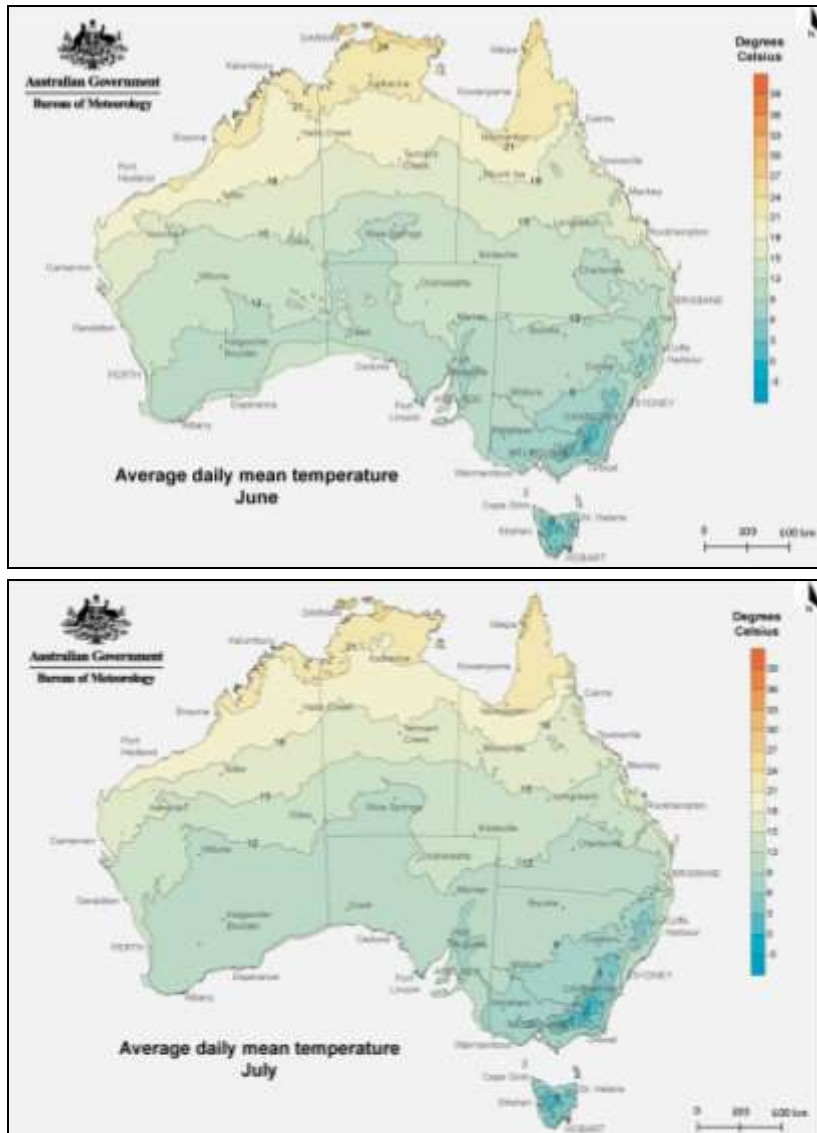


Figure 8a. Average daily Mean Temperatures, Australia, June, July, based on a standard 30-year climatology 1961-1990.

Source: <http://www.bom.gov.au>

During the months of **June and July** (Figure 8a), the southern half of Australia cools below 12 °C , while it ranges from 13-24 in the northern half, whereby it increases the activity of the Corona virus, **In August**, the 12°C heat line shifts southward, reducing the area of land where the risk of spreading the virus decreases, and the area of the thermal zone extends from 12 to 21 °C to include all the central and northern lands, where there is a risk of virus spreading (Figure 8b).

Therefore, the Australian government must take the necessary precautions to reduce the risk of spreading the virus during the spring, autumn and winter seasons.

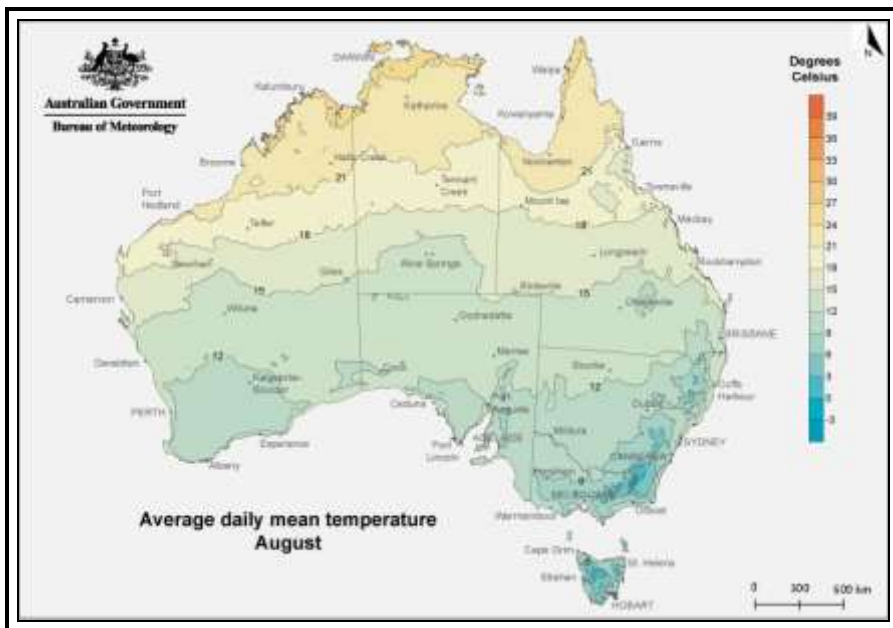


Figure 8b. Average daily Mean Temperatures, Australia, August, based on a standard 30-year climatology 1961-1990.

Source: <http://www.bom.gov.au>

3.2 Egypt Case Study, 2020:

By comparison between Australia, as a country in the Southern Hemisphere, and Egypt, as a country in the Northern Hemisphere, there are significant climatic differences, as the month of April is the heart of autumn in Australia while it is the Heart of Spring in Egypt, and the severity of the impact of temperature on the transmission and activity of Coronavirus is increasing in Australia than in Egypt, where Australia is heading towards winter and lower temperatures, while Egypt is heading to the transition

towards the summer, which has high rates of heat, and thus the activity and transmission of the virus are expected to decrease.

3.2.1 During the Spring:

From Figure (9 a, b and c), which shows the mean daily temperature average in Egypt in the spring, it is clear that:

- In March, the southern half of Egypt is located in a heat range from 25 to 32 °C, and all of the governorates of the Delta, Matrouh, the Sinai Peninsula, the northern Red Sea governorate, and the north of the New Valley Governorate are in a temperature range of 16 to 24 °C. The number of confirmed cases was 710 vs 4560 in Australia.
- In April, most of the Egyptian lands are located in a temperature average of more than 24°C, except for most of the Sinai Peninsula and the northern coast of Egypt from Rafah to Salloum. Its temperature ranges between 20-24 degrees Celsius.
- In May, temperatures rise above 26 degrees Celsius in all Egyptian lands, ranging between 26 degrees on the northern coasts, the Red Sea coasts and most of the Sinai lands, but in southern Egypt the temperature reaches 42 degrees.

From the above, it is clear that the effect of temperature on transmission and activity of COVID-19 in Egypt was higher in March than April, while the activity and transmission of the virus will be completely weakened in May, Excluding the impact of other factors. It remains the role of citizens in adhering to health rules, social separation and sanitary isolation, in order to prevent transmission of the virus from one person to another, Especially indoor and air-conditioned places.

3.2.2 During the Summer:

From Figure (10 a, b and c), which shows the mean daily temperature average in Egypt in the summer, it is clear that temperatures will be between 28-40 degrees in June and between 30-40 in July and August all over Egypt.

3.2.3 During the Autumn:

From Figure (11 a, b and c), which shows the mean daily temperature average in Egypt in the autumn it is clear that In September, most of the Egyptian lands will be in a temperature range higher than 28 degrees. In October, the rate will be between 26 degrees in the far north and 38 degrees in the far south. In November, the line between Assiut and Hurghada divides Egypt into almost two halves, the northern half will have a mean temperature of less than 24 degrees, and the southern half will have a temperature above 24 degrees.

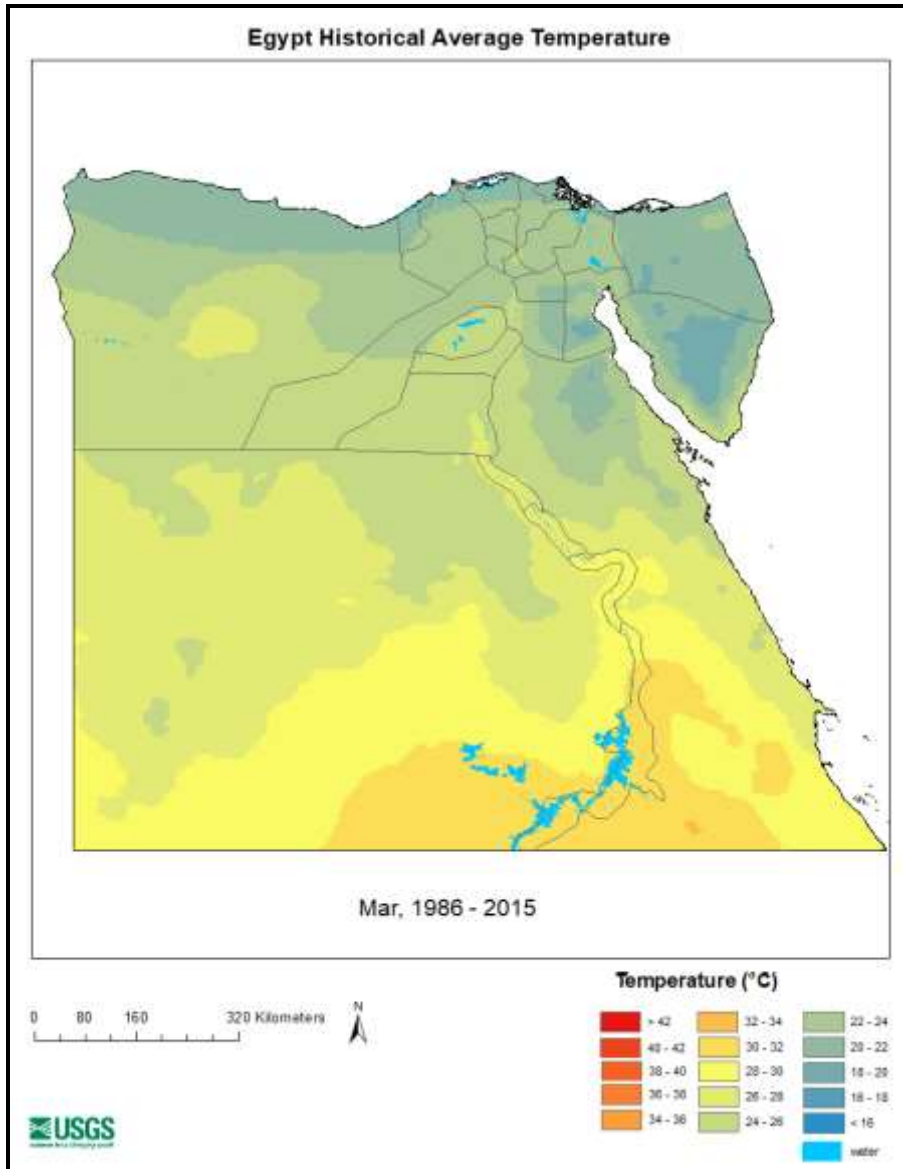


Figure 9a. Average daily Mean Temperatures, in Spring (March), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

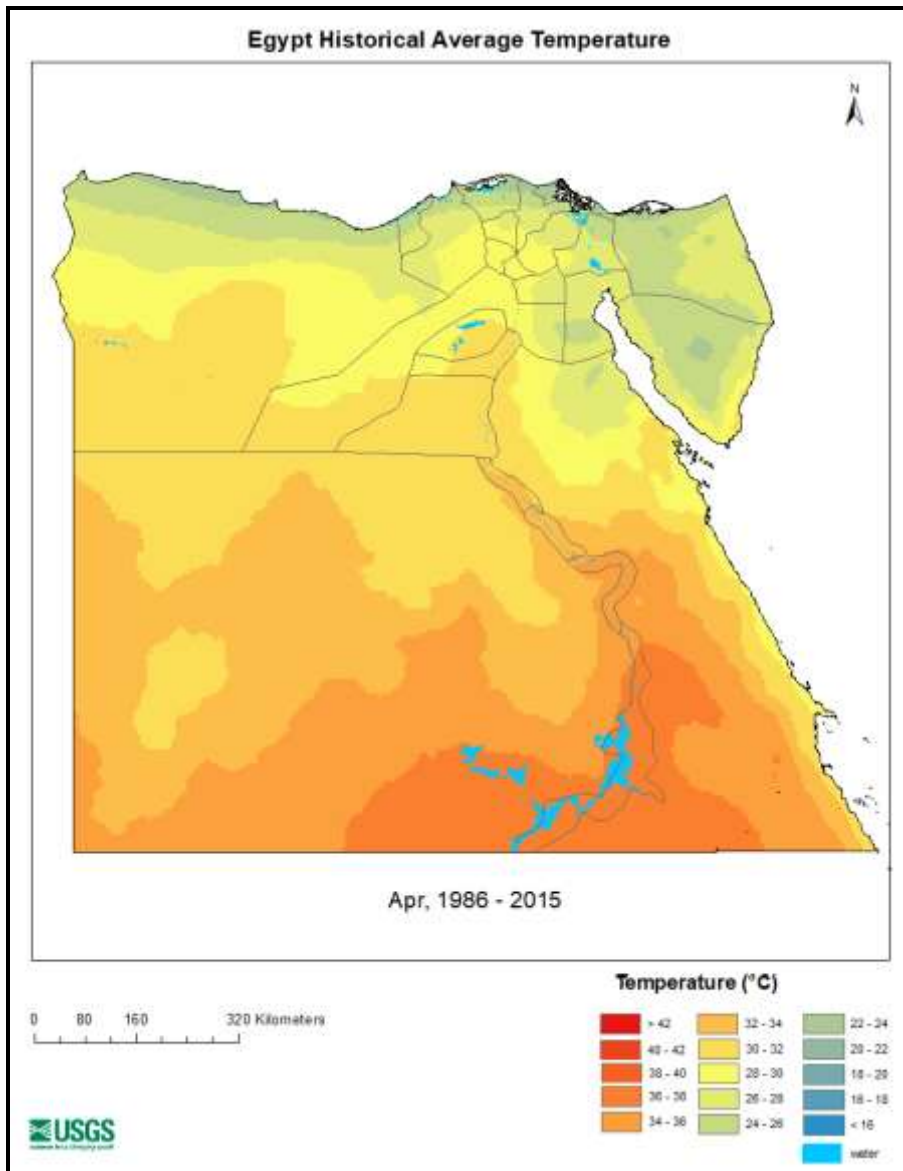


Figure 9b. Average daily Mean Temperatures, in Spring (April), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

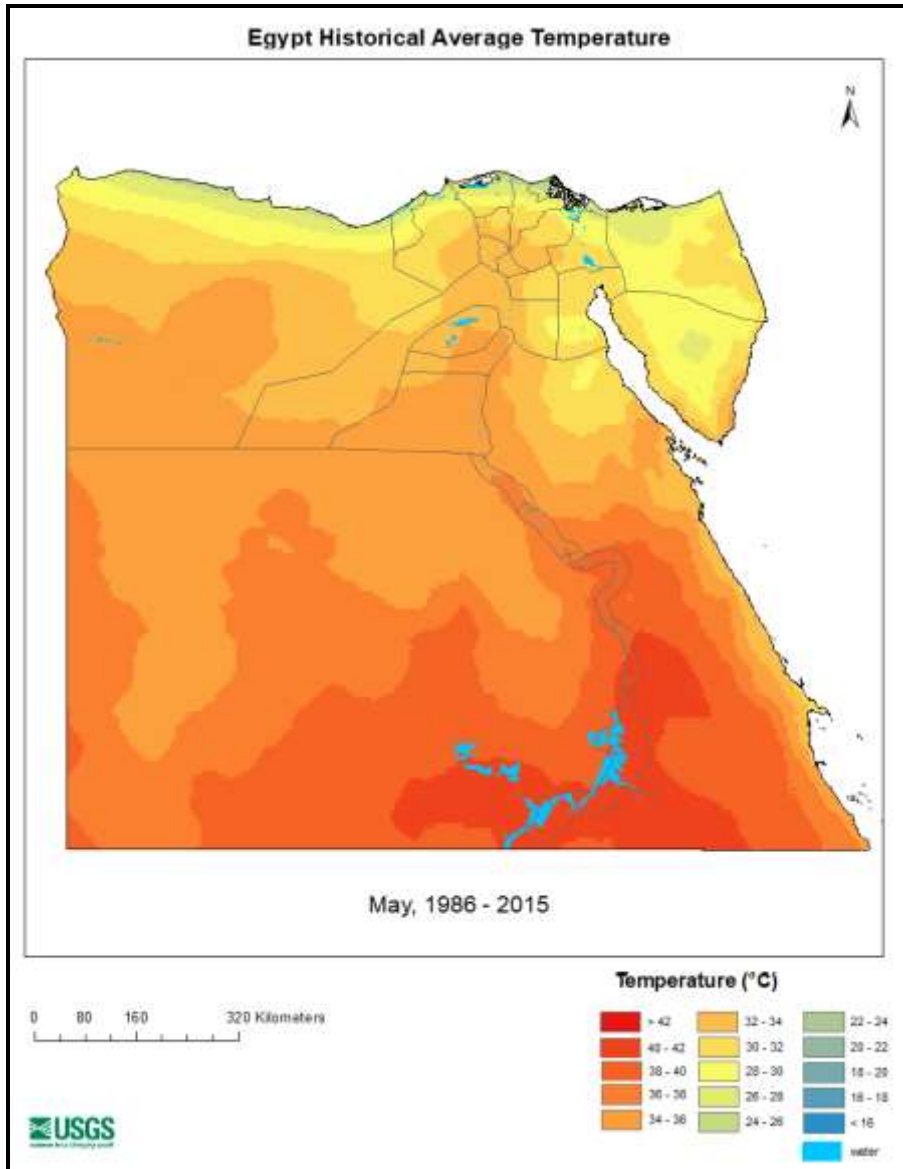


Figure 9c. Average daily Mean Temperatures, in Spring (May), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

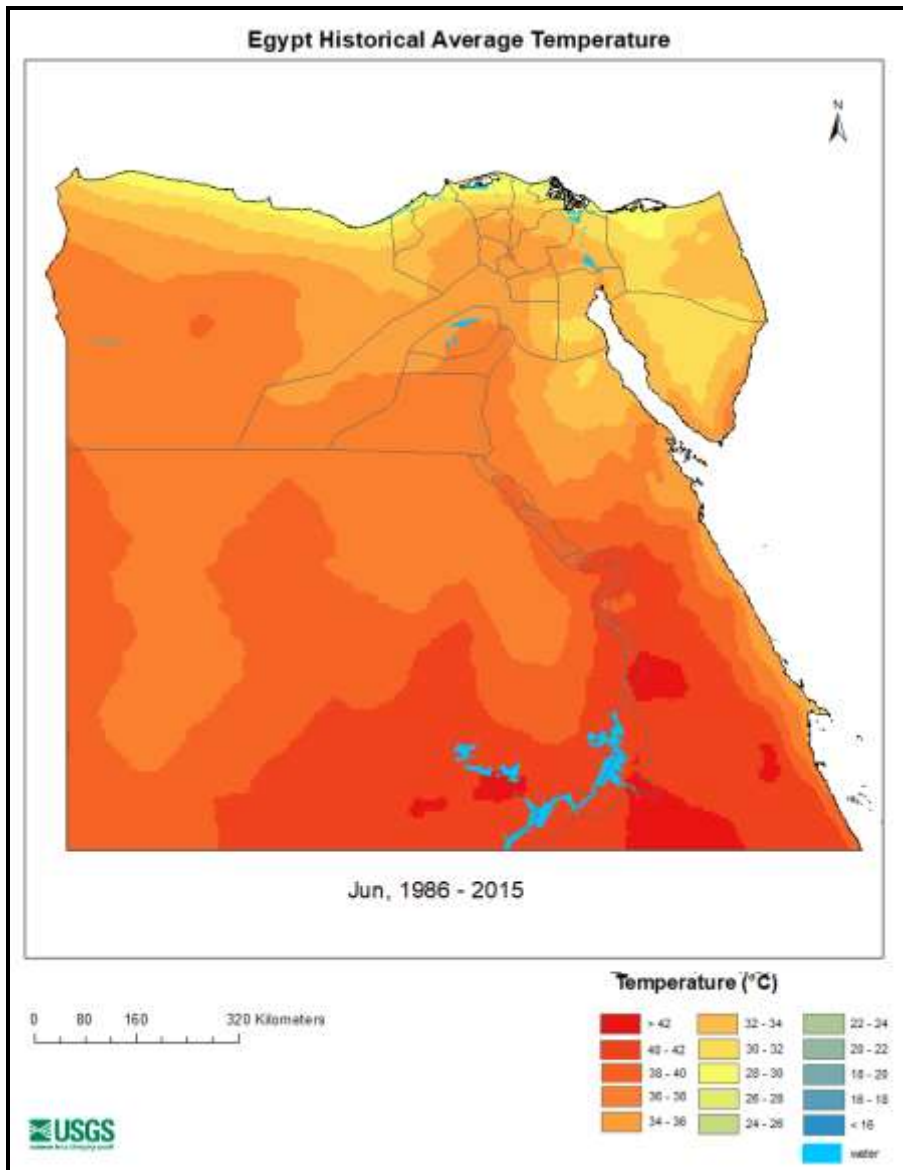


Figure (10-a) Average daily Mean Temperatures, in Summer (Jun), Egypt (1986-2015)

Source: <https://earlywarning.usgs.gov/fews/product/698>

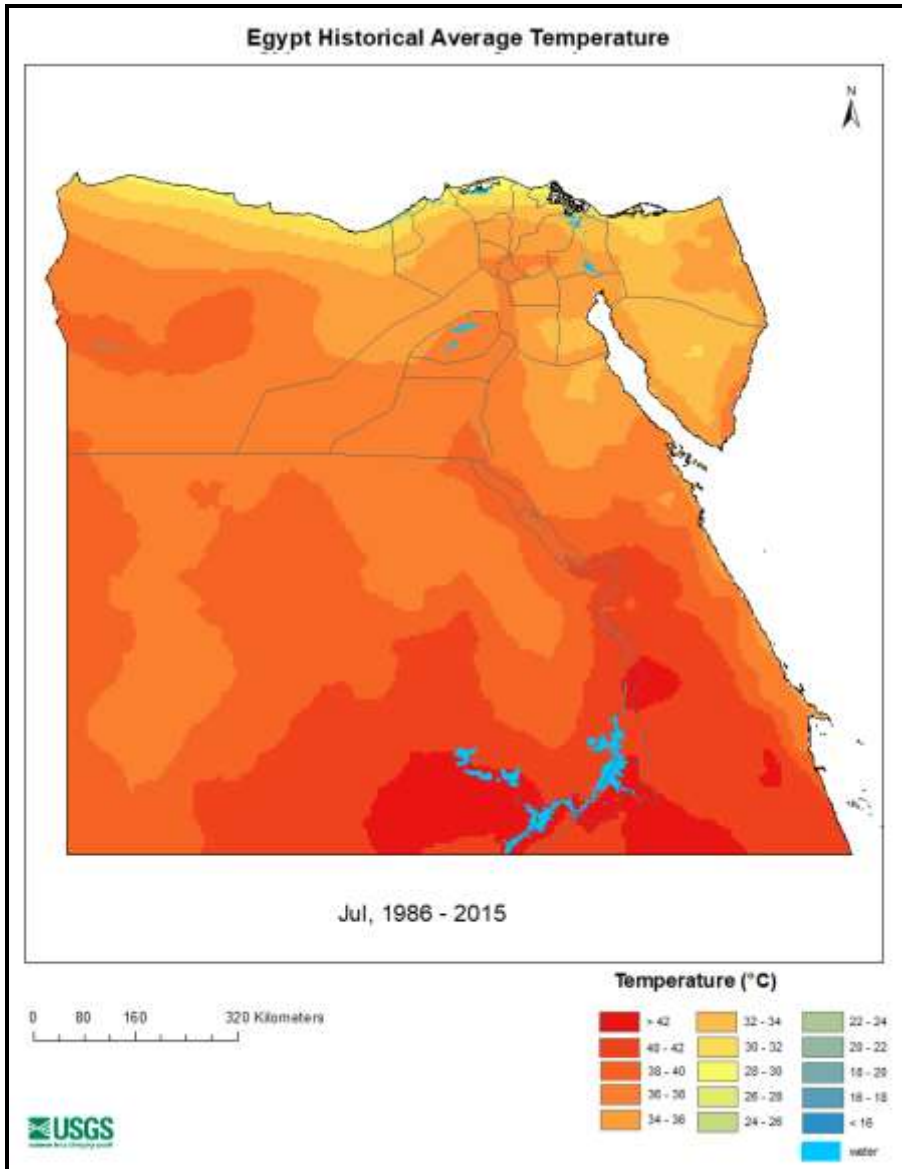


Figure 10b. Average daily Mean Temperatures, in Summer (Jul), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

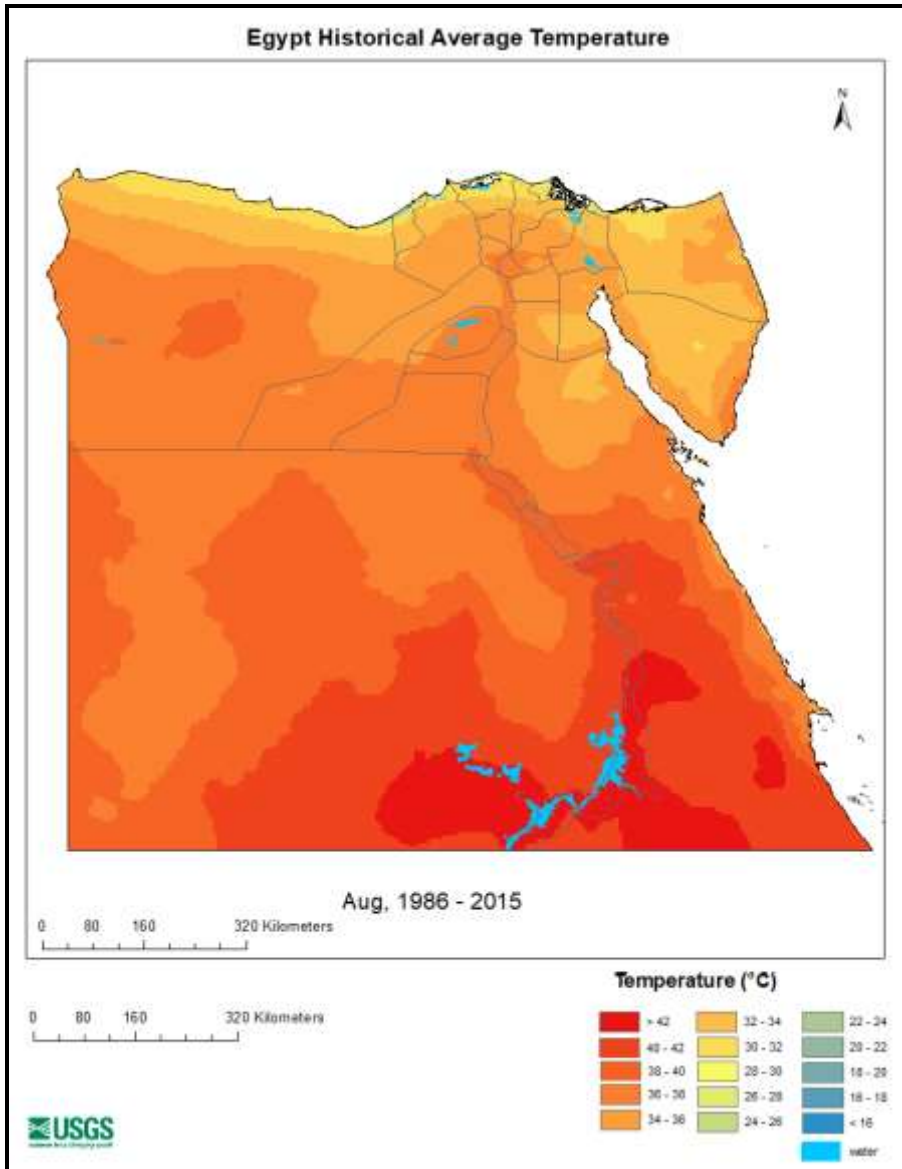


Figure 10c. Average daily Mean Temperatures, in Summer (Aug), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

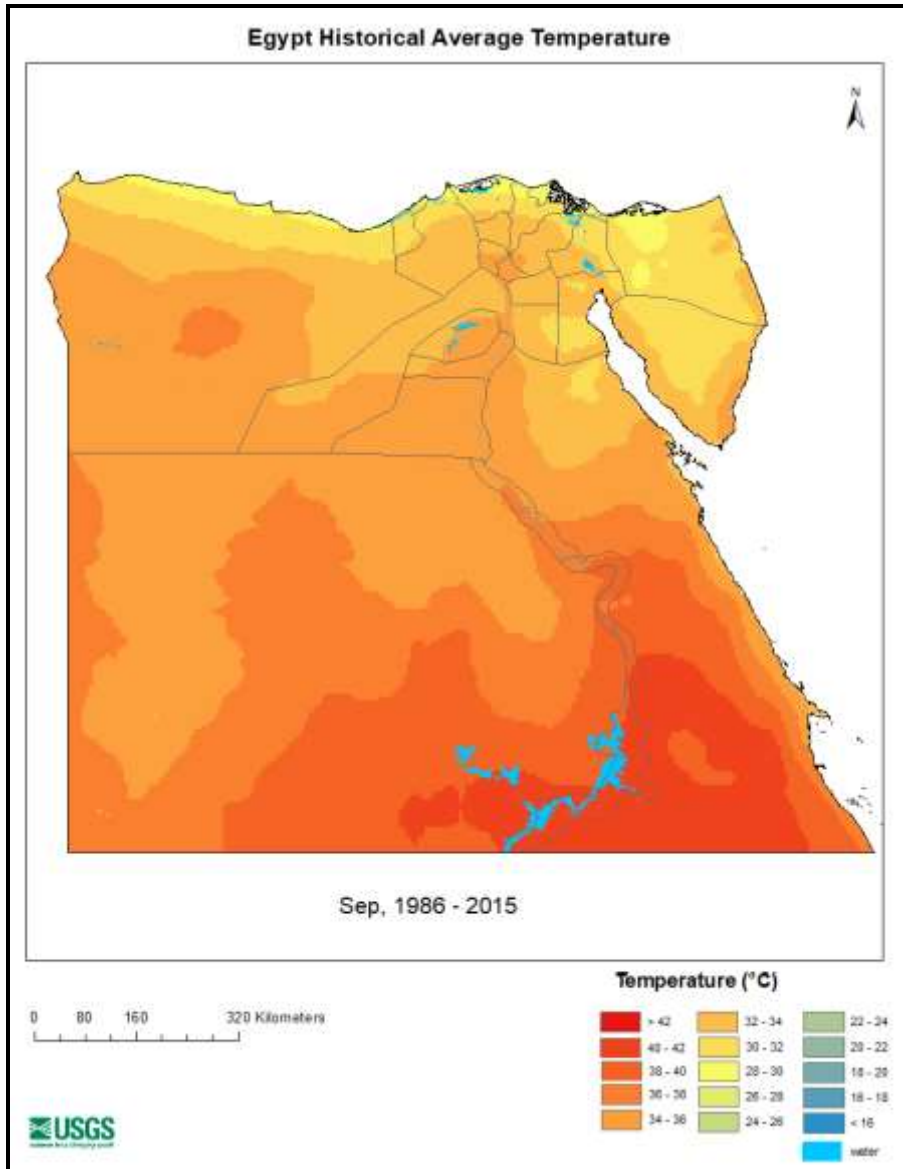


Figure 11a. Average daily Mean Temperatures, in Autumn (Sep), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

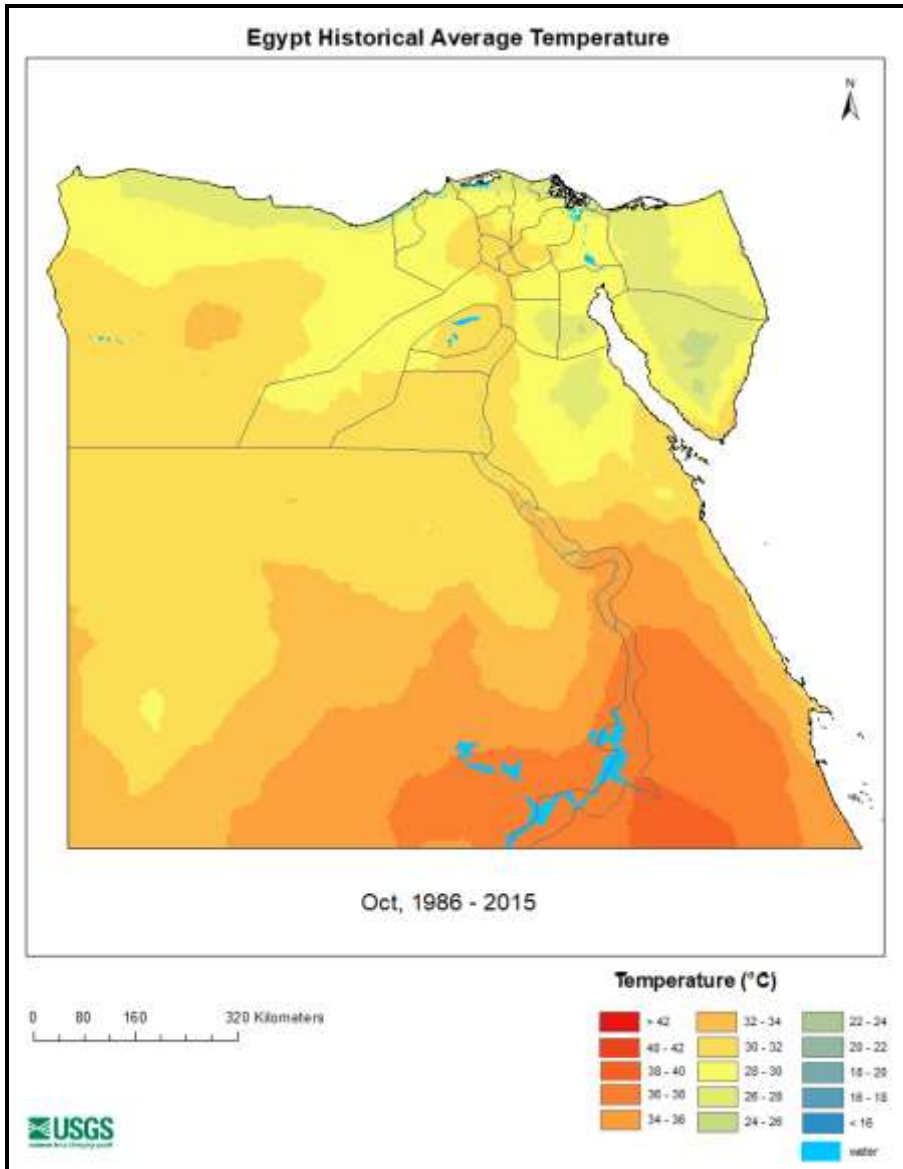


Figure 11b. Average daily Mean Temperatures, in Autumn (Oct), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

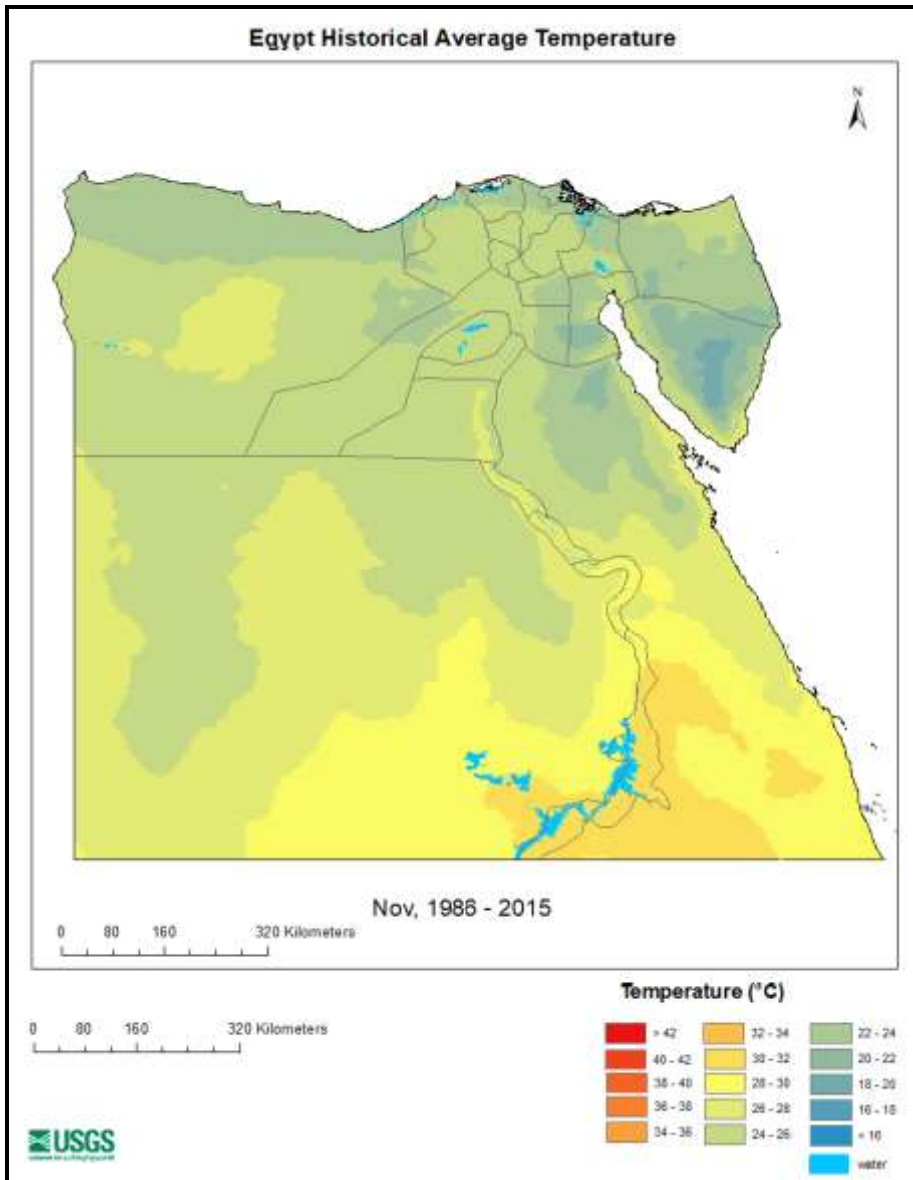


Figure 11c. Average daily Mean Temperatures, in Autumn (Nov), Egypt (1986-2015).

Source: <https://earlywarning.usgs.gov/fews/product/698>

4. Results

The study reached, through cartographic analysis, to confirm the inverse correlation relationship between temperature and increase in the number of confirmed cases in Australia during the month of March, and also the decrease in the number of cases in Egypt in the same month, The number of confirmed cases was 710 in Egypt vs 4560 in Australia. The study expects that, Excluding the influence of other factors, the countries of the northern hemisphere will turn to more hot seasons, which means low virus activity and weak transmission. On the contrary, the countries of the southern hemisphere are heading towards less hot seasons and thus the possibility of more activity of the virus and a greater possibility of transmission. In both cases, people must adhere to health and social instructions to prevent transmission of the virus from one person to another.

5. Conclusions

Most appropriate average temperature for the survival transmission of COVID-19 ranges between 13-24 °C. Australia and Egypt are models to confirm the relationship between temperature and COVID-19 activity and spread. Globally, cities with a mean temperature below 24 °C are all high-risk cities for COVID-19 transmission. Especially in the spring, autumn and winter. Therefore, countries should take the necessary precautions to prevent the spread of the epidemic.

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تأثير درجة الحرارة على انتقال فيروس كوفيد-١٩: دراسة حالي مصر وأستراليا خلال
الفترة يناير - مارس ٢٠٢٠

عدلي أنيس سليمان

الملخص العربي

تم الإبلاغ مؤخرًا عن مرض تنفسي حاد في ووهان، مقاطعة هوبي، بالصين بسبب فيروس كورونا كوفيد-١٩. وفي ٢٥ يناير ٢٠٢٠ تم الإبلاغ عن ١٩٧٥ حالة على الأقل منذ دخول المريض الأول إلى المستشفى في ١٢ ديسمبر ٢٠١٩، وقد أشارت التحقيقات الوبائية إلى أن الفاشية كانت مرتبطة بسوق المأكولات البحرية في ووهان. ونظرًا لسرعة انتشار الوباء وإعلان منظمة السياحة العالمية انه وباء عالميا حاولت الورقة اختبار نتائج الدراسات الصينية السابقة، والتي أقرت بأن متوسط درجة الحرارة الأنسب لنشاط الفيروس وانتقاله يتراوح بين ١٣-٢٤ درجة مئوية، في الواقع من خلال خرائط لمتوسط درجة الحرارة الشهرية خلال الفترة من يناير إلى مارس ٢٠٢٠. ومن خلال دراسات حالة لأستراليا ومصر - بسبب توافر البيانات المناخية وأعداد الحالات المؤكدة - حاولت الدراسة التنبؤ بمستقبل انتشار الفيروس خلال المواسم التالية باستخدام الأسلوب الكارثوجرافي توصلت الدراسة - من خلال تحليل الخرائط - إلى تأكيد علاقة الارتباط العكسي بين درجة الحرارة وزيادة عدد الحالات المؤكدة في أستراليا خلال شهر مارس من ناحية، وانخفاض عدد الحالات في مصر في نفس الفترة من ناحية أخرى.

الكلمات المفتاحية: كوفيد-١٩، انتقال كوفيد-١٩، درجة الحرارة، أستراليا، مصر.