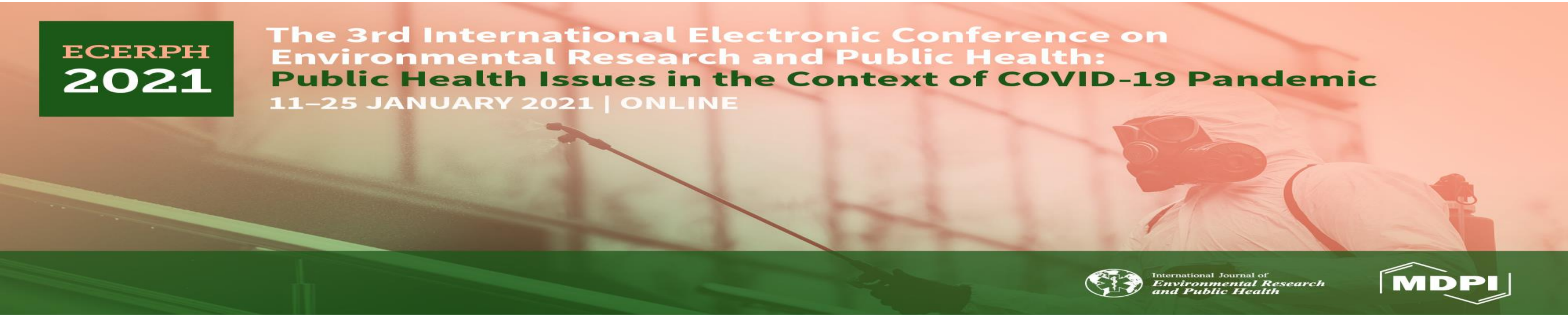


THE IMPACT OF THE AVERAGE TEMPERATURE, HUMIDITY, WIND SPEED, ALTITUDE AND POPULATION DENSITY ON DAILY COVID-19 INFECTIONS' EVOLUTION

Rachid LAGTAYI, Lamya LAIRGI , Abdelmajid DAYA, Ahmed KHOUYA

PLAN

1 Introduction

2 Data bases

3 Results and Discussion

Conclusion

1918-1920

- Spanish Flu
- 39 million of deaths
- 2% of the world population

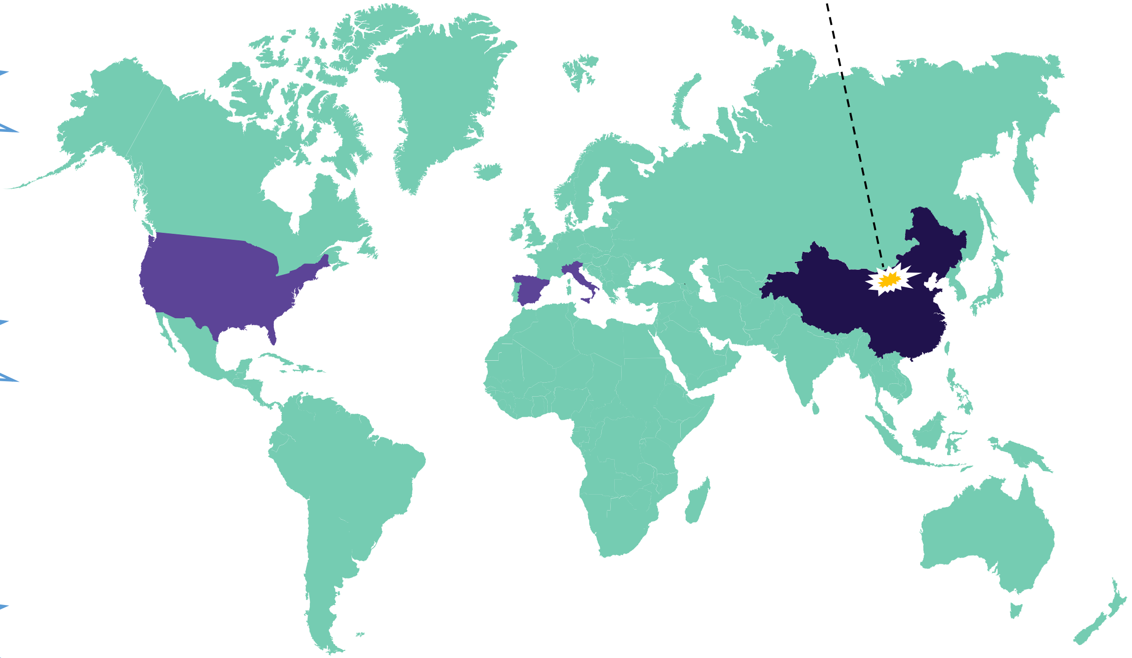
Swin Flu

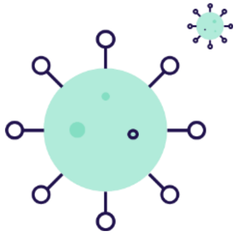
Sars

Ebola

Mers

December 2019
COVID 19





30th April 2020

3,090,445
Detected Cases

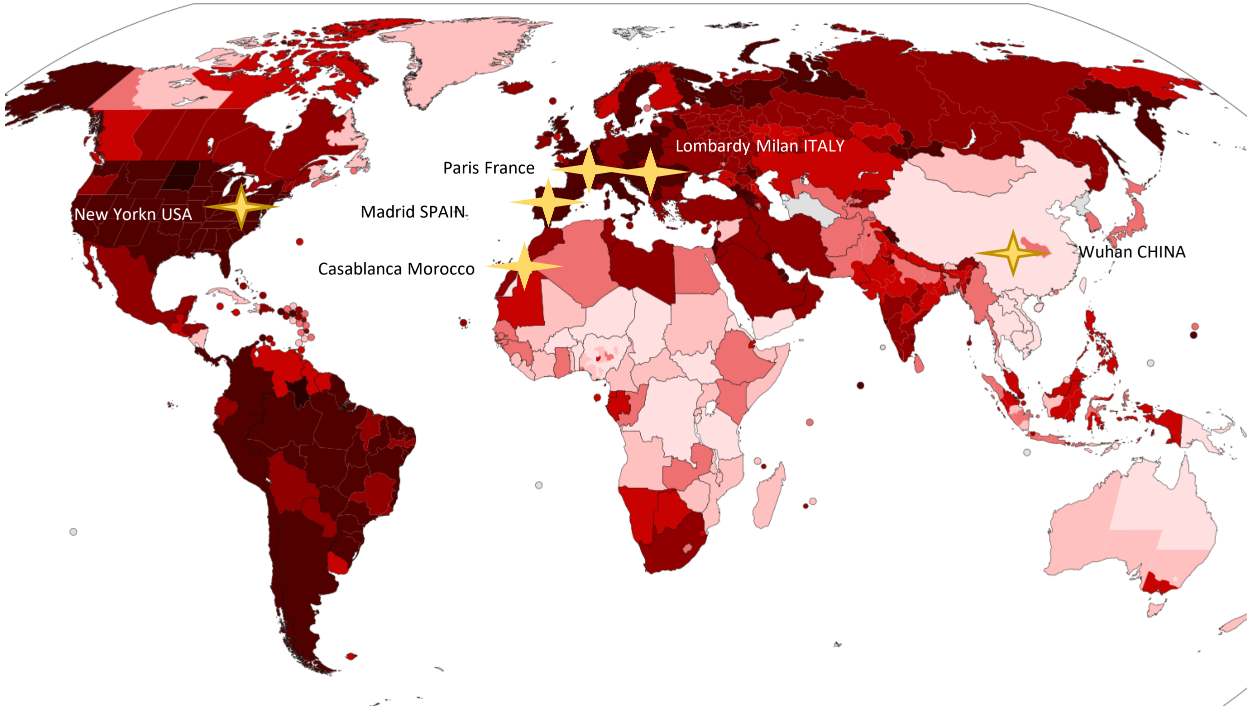
217,769
Deaths

1,030,715
recovered

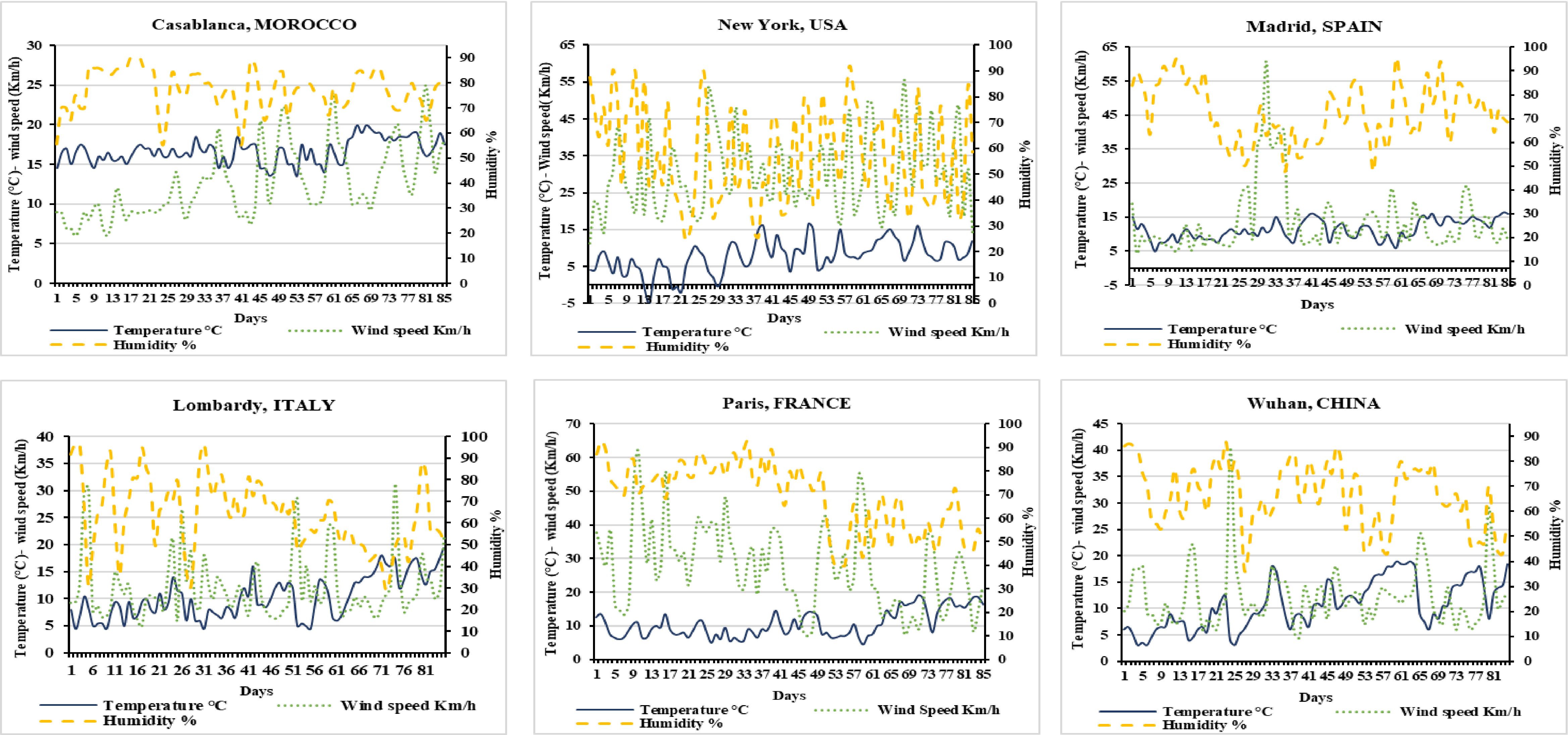
World Health Organization **has announced a state of emergency**

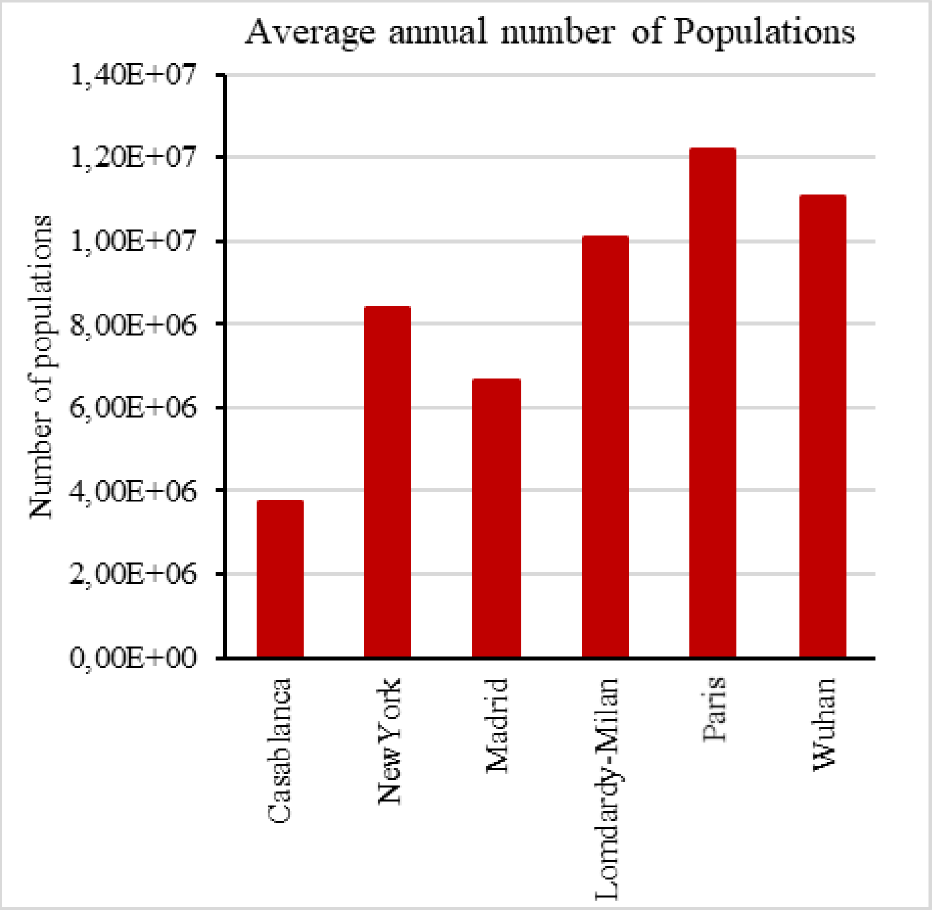
Study the impact of the daily average wind speed and population density on the daily number of COVID-19 infection's evolution around six different cities

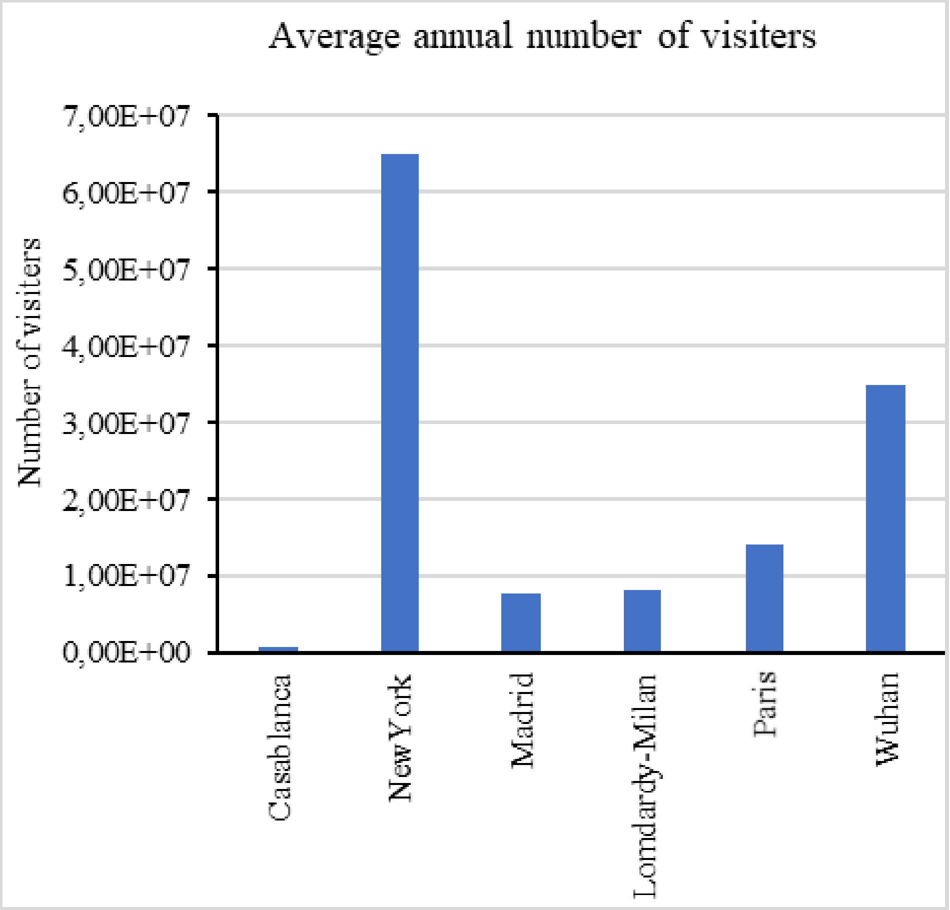
February the 1st to the 25th of April 2020



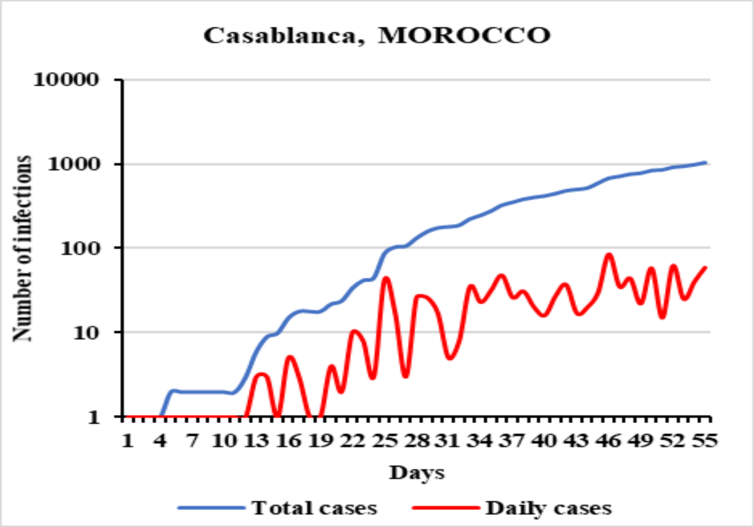
Climate data | Polulation density data | Daily and cumulated COVID-19 infections

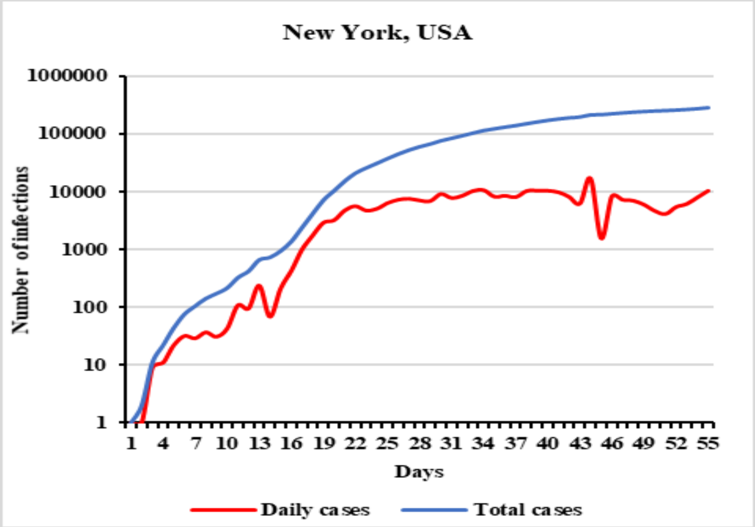


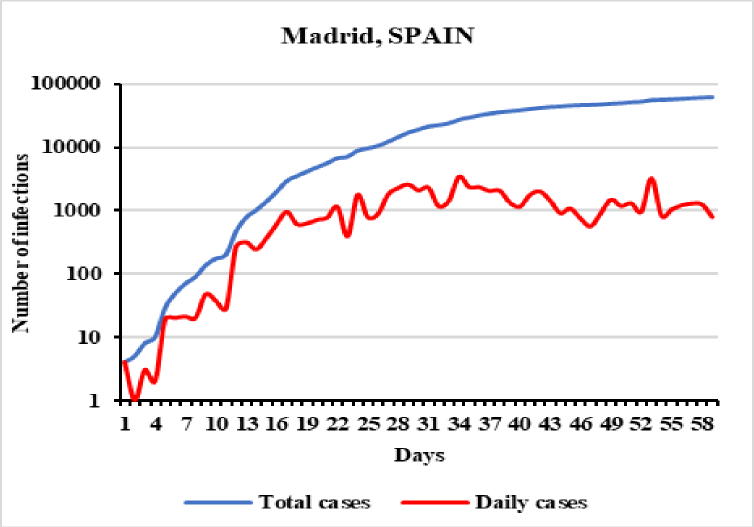

Average annual number of Populations
Number of populations
1,40E+07
1,20E+07
1,00E+07
8,00E+06
6,00E+06
4,00E+06
2,00E+06
0,00E+00
Casablanca
New York
Madrid
Lomdardy-Milan
Paris
Wuhan

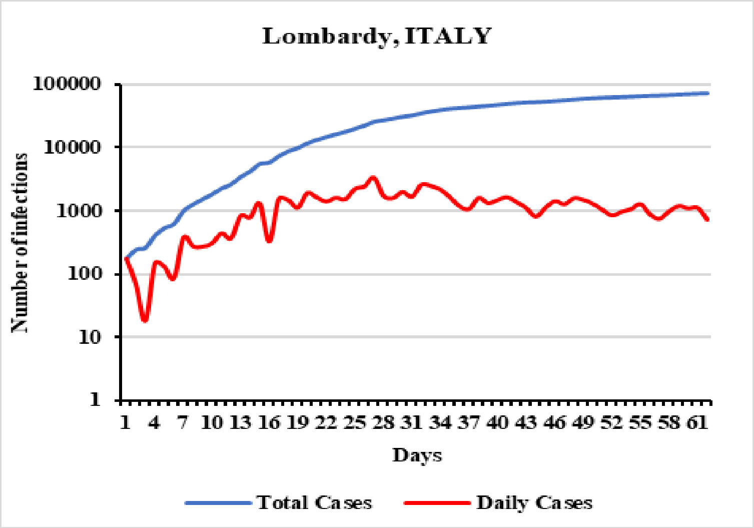

Average annual number of visiters
Number of visiters
7,00E+07
6,00E+07
5,00E+07
4,00E+07
3,00E+07
2,00E+07
1,00E+07
0,00E+00
Casablanca
New York
Madrid
Lomdardy-Milan
Paris
Wuhan

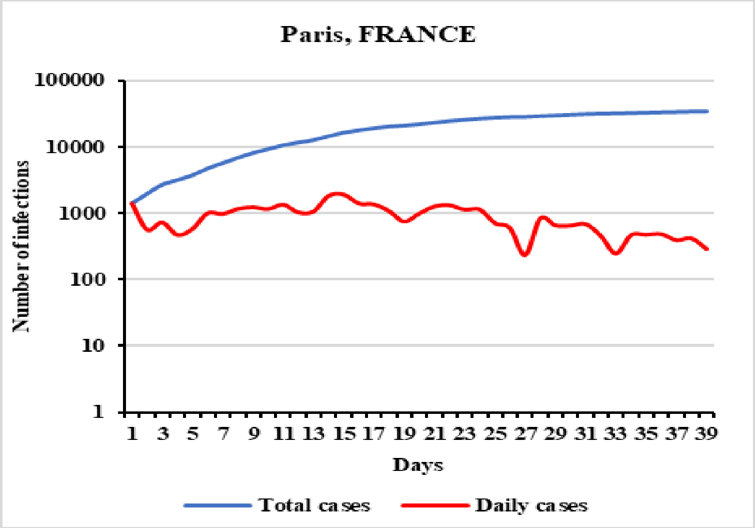
Daily and cumulated COVID-19 infections

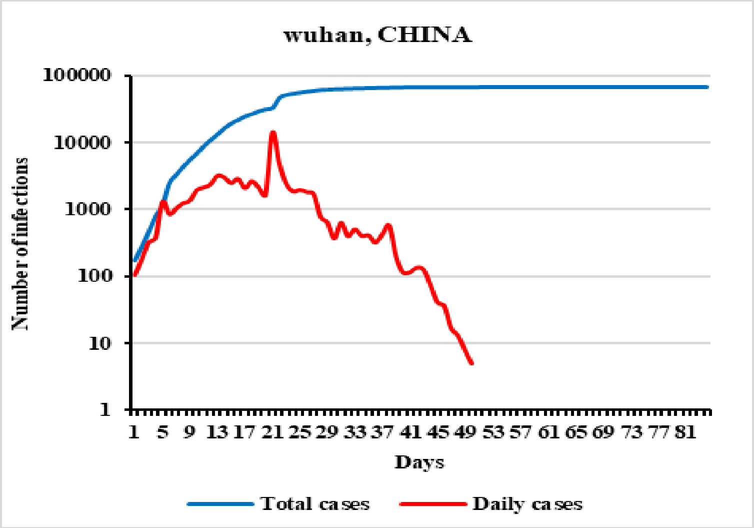


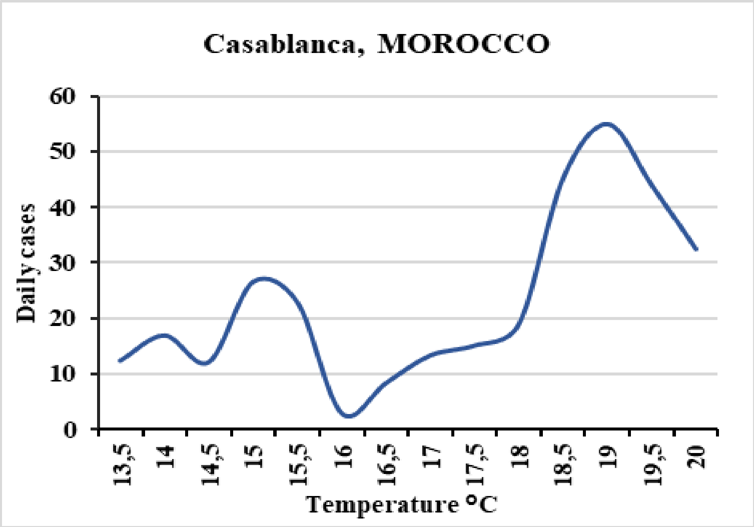


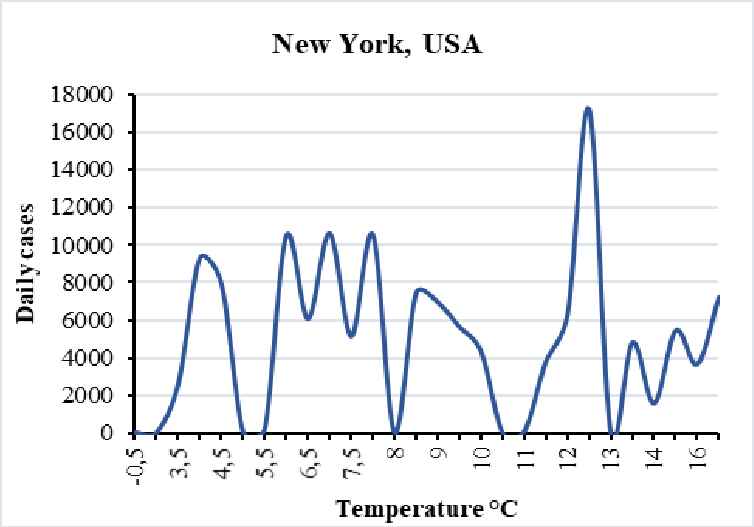


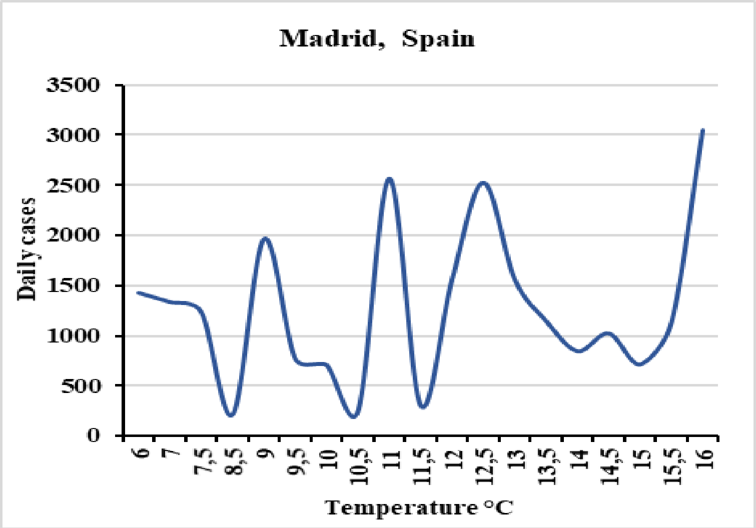


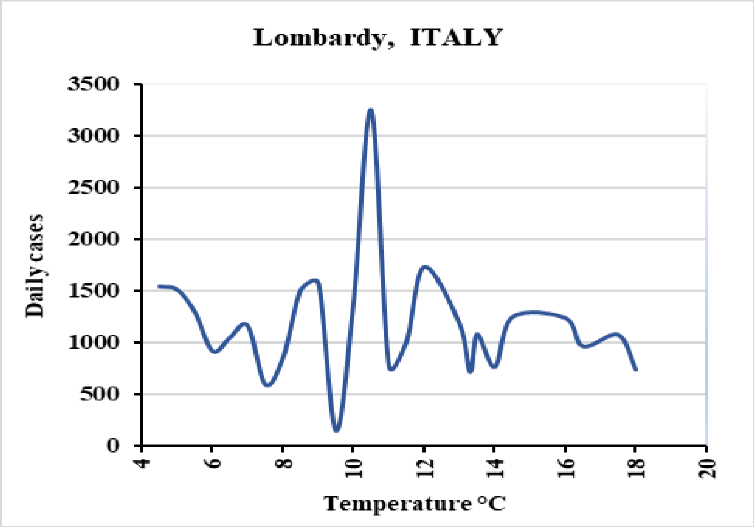


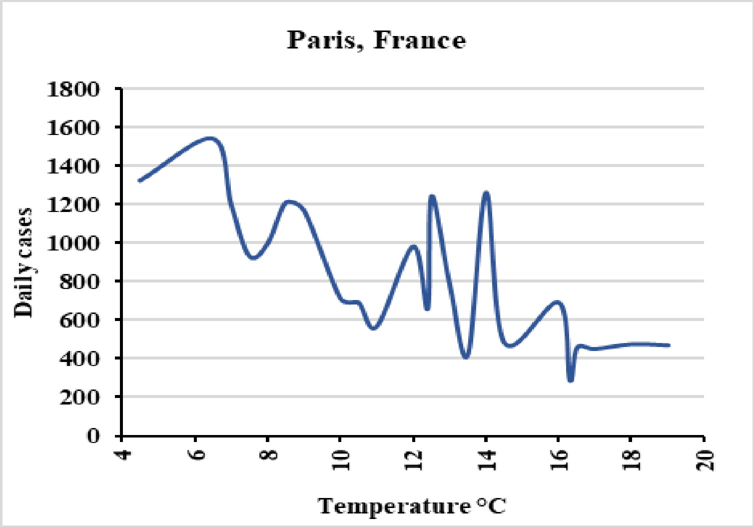


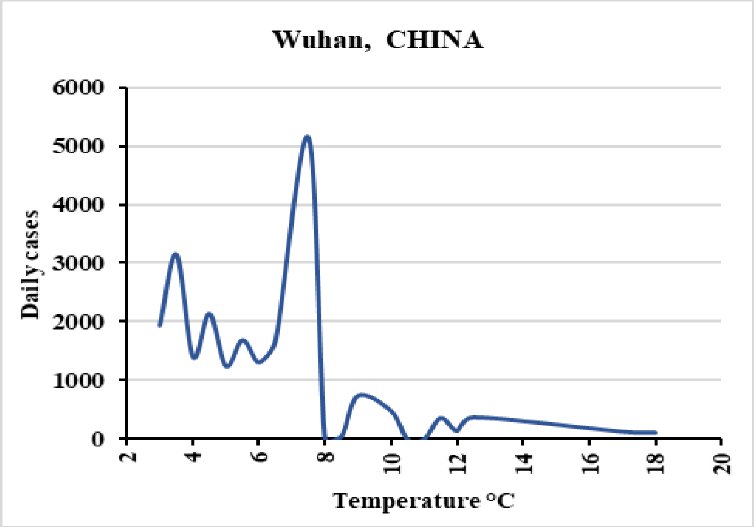

Casablanca, MOROCCO
Daily cases
0 10 20 30 40 50 60
13,5 14 14,5 15 15,5 16 16,5 17 17,5 18 18,5 19 19,5 20
Temperature °C

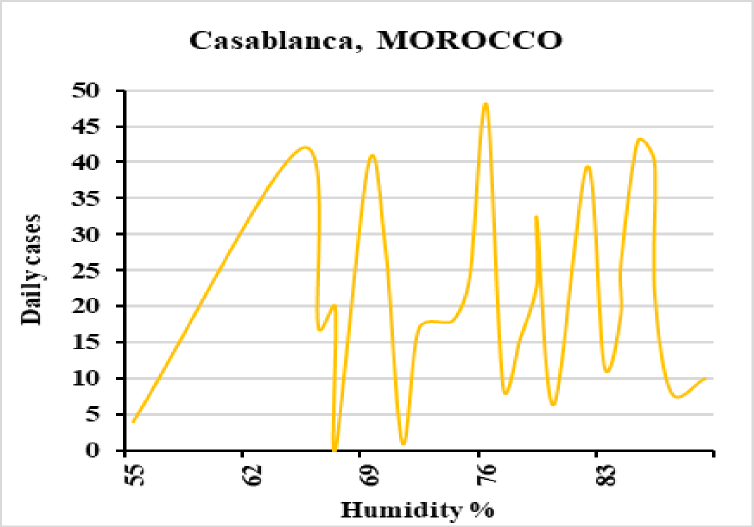

New York, USA
Daily cases
0 2000 4000 6000 8000 10000 12000 14000 16000 18000
-0,5 3,5 4,5 5,5 6,5 7,5 8 9 10 11 12 13 14 16
Temperature °C

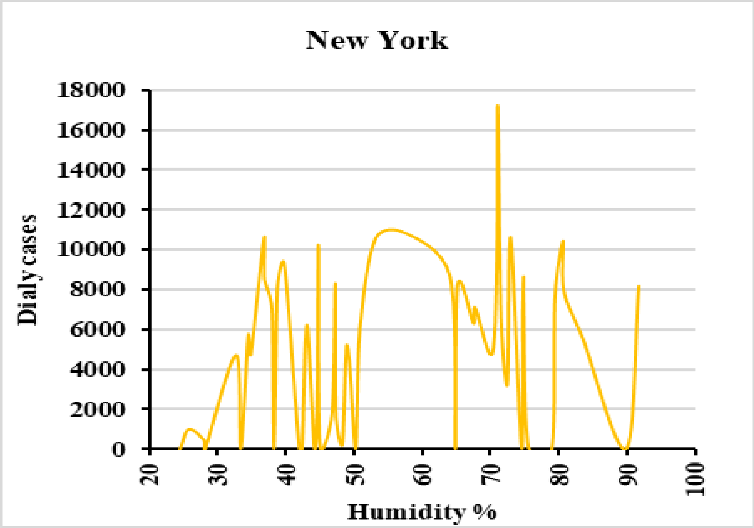

Madrid, Spain
Daily cases
0 500 1000 1500 2000 2500 3000 3500
6 7 7,5 8,5 9 9,5 10 10,5 11 11,5 12 12,5 13 13,5 14 14,5 15 15,5 16
Temperature °C

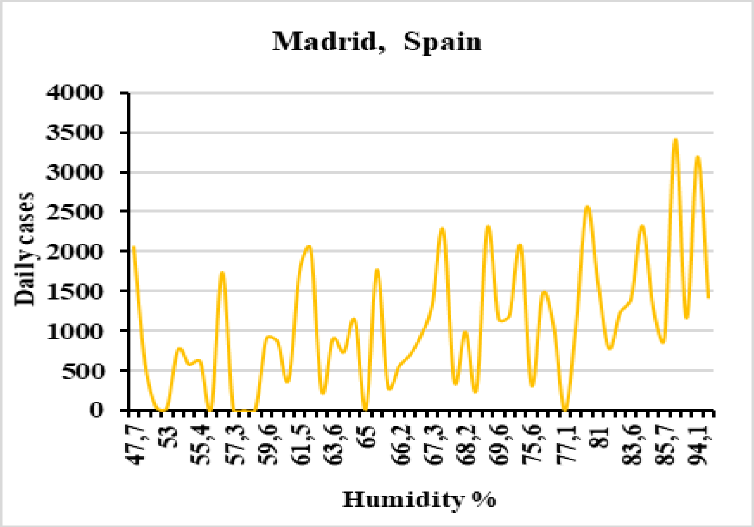

Lombardy, ITALY
Daily cases
0 500 1000 1500 2000 2500 3000 3500
4 6 8 10 12 14 16 18 20
Temperature °C

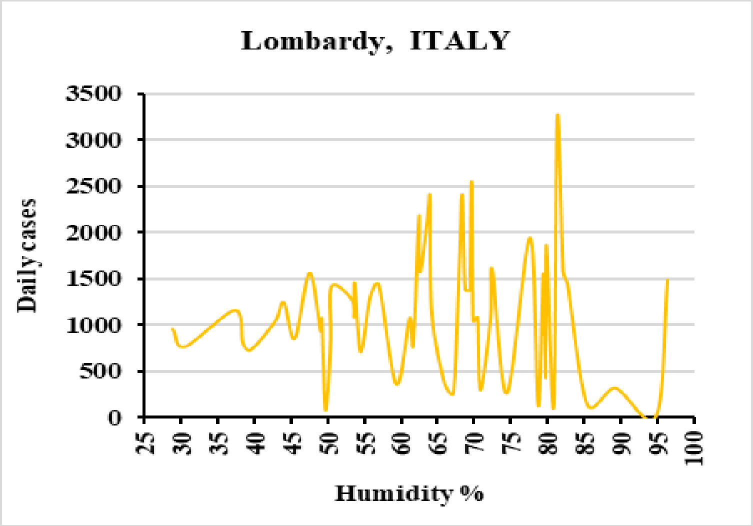

Paris, France
Daily cases
0 200 400 600 800 1000 1200 1400 1600 1800
4 6 8 10 12 14 16 18 20
Temperature °C

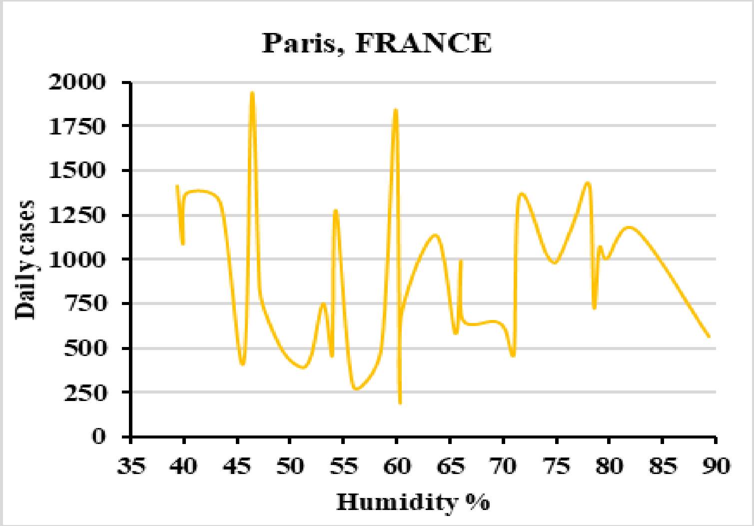

Wuhan, CHINA
Daily cases
0 1000 2000 3000 4000 5000 6000
2 4 6 8 10 12 14 16 18 20
Temperature °C

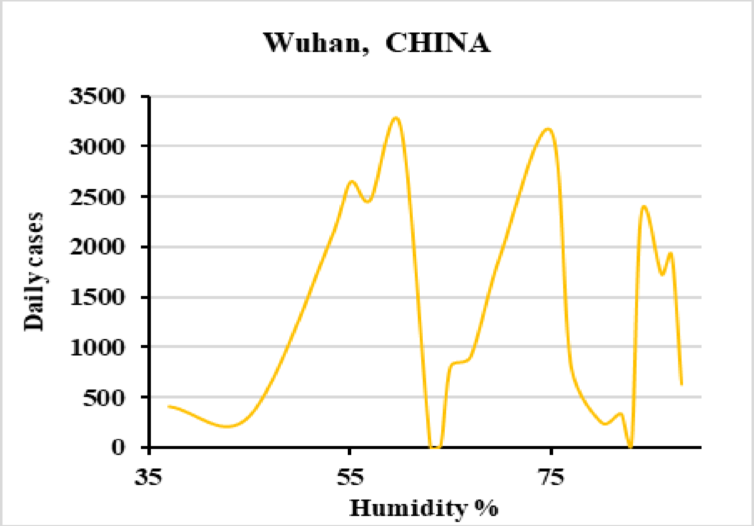

Casablanca, MOROCCO
Daily cases
0 5 10 15 20 25 30 35 40 45 50
55 62 69 76 83
Humidity %

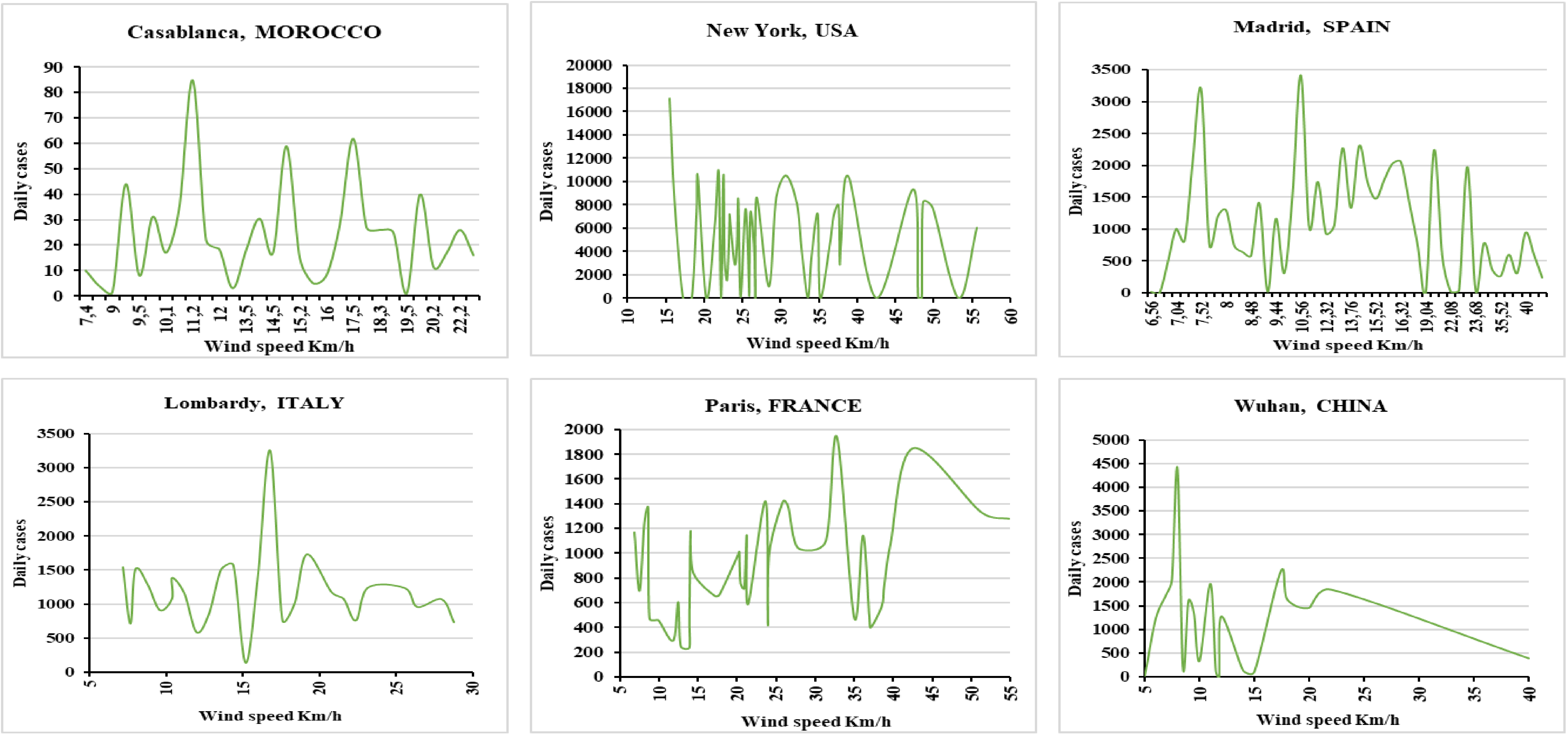

New York
Daily cases
0 2000 4000 6000 8000 10000 12000 14000 16000 18000
20 30 40 50 60 70 80 90 100
Humidity %

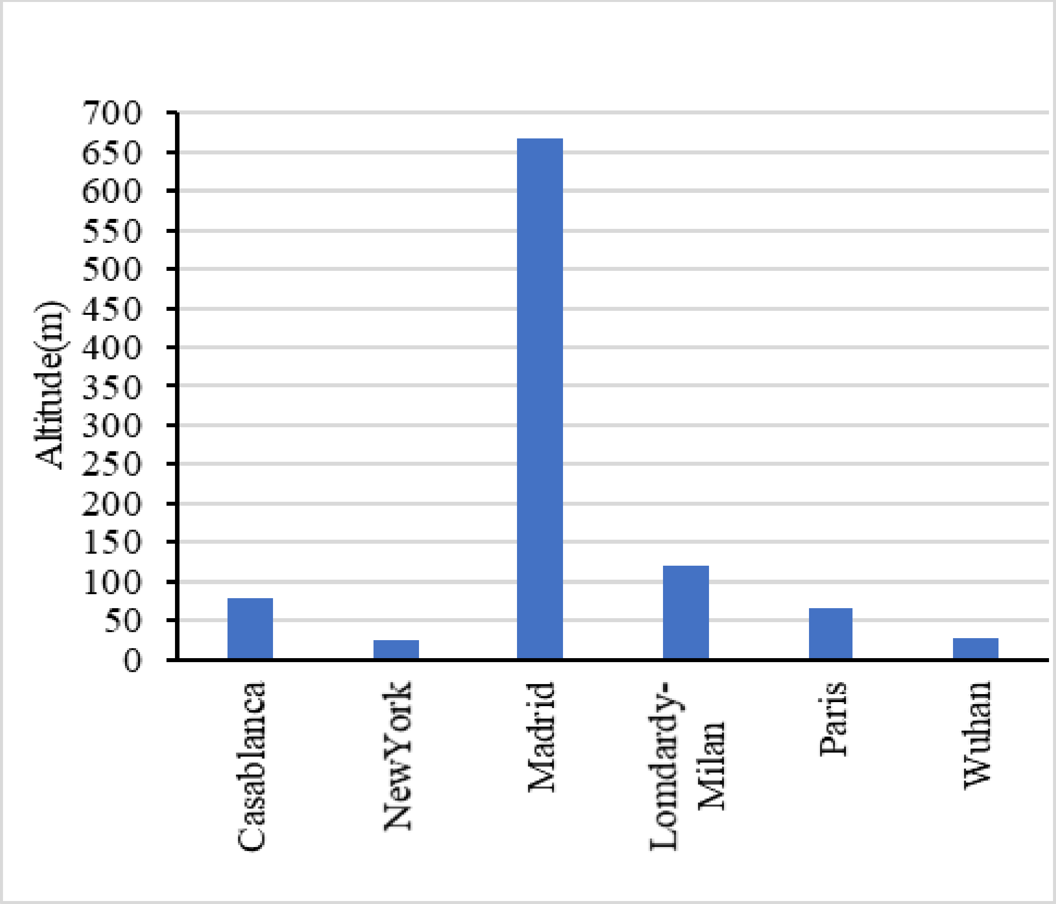

Madrid, Spain
Daily cases
0 500 1000 1500 2000 2500 3000 3500 4000
47,7 53 55,4 57,3 59,6 61,5 63,6 65 66,2 67,3 68,2 69,6 75,6 77,1 81 83,6 85,7 94,1
Humidity %

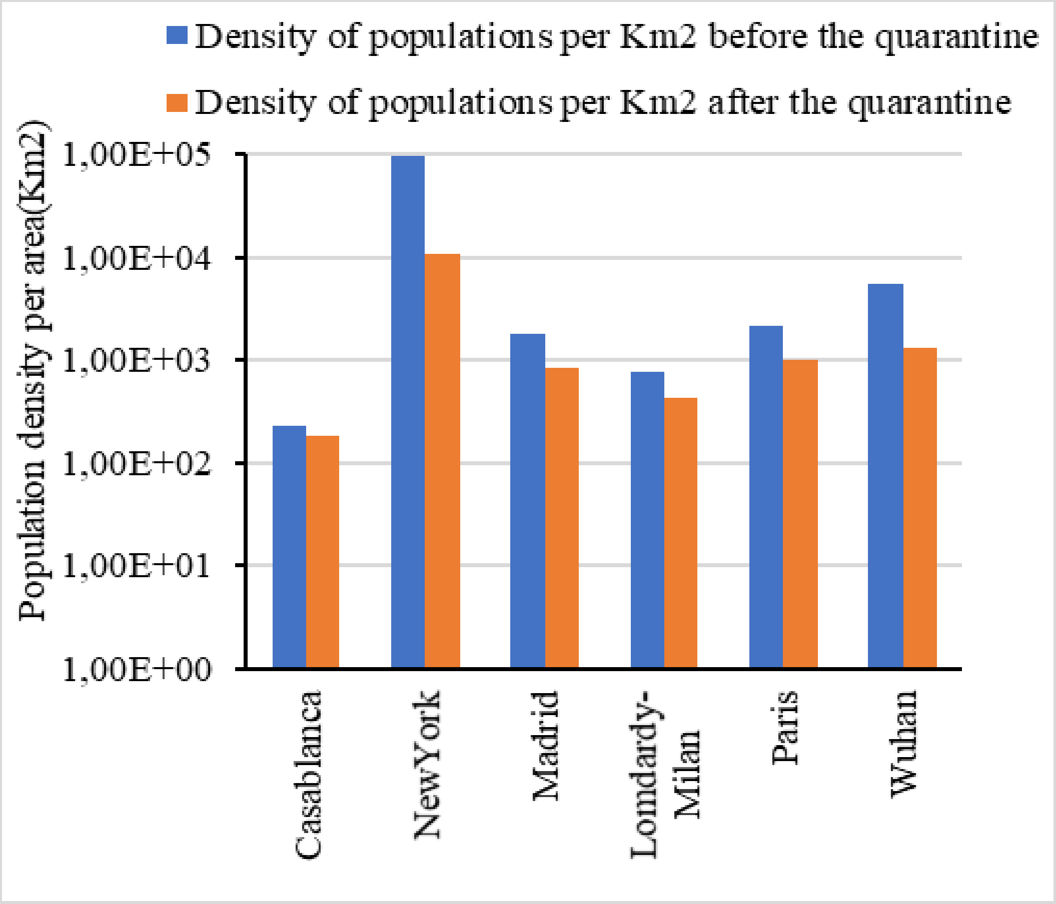

Lombardy, ITALY
Daily cases
0 500 1000 1500 2000 2500 3000 3500
25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Humidity %


Paris, FRANCE
Daily cases
0 250 500 750 1000 1250 1500 1750 2000
35 40 45 50 55 60 65 70 75 80 85 90
Humidity %


Wuhan, CHINA
Daily cases
0 500 1000 1500 2000 2500 3000 3500
35 55 75
Humidity %


Casablanca, MOROCCO
Daily cases
Wind speed Km/h
New York, USA
Daily cases
Wind speed Km/h
Madrid, SPAIN
Daily cases
Wind speed Km/h
Lombardy, ITALY
Daily cases
Wind speed Km/h
Paris, FRANCE
Daily cases
Wind speed Km/h
Wuhan, CHINA
Daily cases
Wind speed Km/h


Altitude(m)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Casablanca
NewYork
Madrid
Lomdardy-Milan
Paris
Wuhan


Density of populations per Km2 before the quarantine
Density of populations per Km2 after the quarantine
Population density per area(Km2)
1,00E+05
1,00E+04
1,00E+03
1,00E+02
1,00E+01
1,00E+00
Casablanca
NewYork
Madrid
Lomdardy-Milan
Paris
Wuhan

To estimate the impact of climatic parameters (Wind speed W_i) and population density on the variations of daily COVID-19 infections around the six cities under study.

- Before quarantine: $P_{total} = P_s + P_t$
- After quarantine: $P_{total} = P_s$

- P_s Average annual population density in a city
- P_t Average annual visitors' density across each city

- The average annual number of populations N(t) in a city could be presented as(You et al. 2020):

N(t)=S(t)+I(t)+R(t)

- S (t): Number of susceptibles on day t.
- I (t): Number of infected cases on day t.
- R (t): Number of recovered patients on day t.

- The variables S (t), I (t) and R (t) vary over time and they could be presented by SIR model by a system of three differential equations as follow(McCluskey 2010; Satsuma et al. 2004):

$$\begin{cases} \dfrac{dS}{dt} = -aS(t).I(t) \\ \dfrac{dI}{dt} = aS(t).I(t) - bI(t) \\ \dfrac{dR}{dt} = bI\ (t) \end{cases}$$

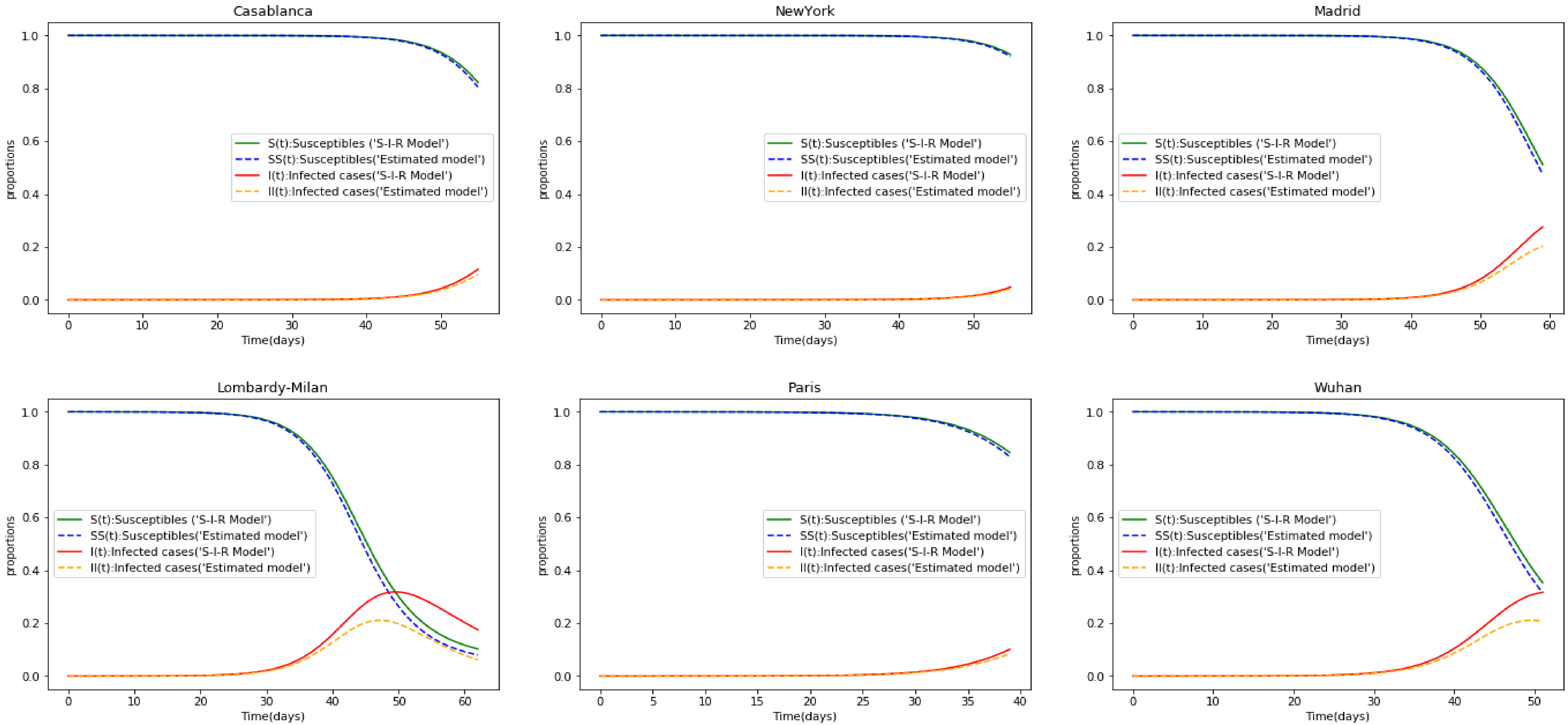
- a: expected amount of people an infected person infects per day (a≃1/tip).
- b: Proportion of recovered patients per day (b = 1/D), (D=14 days in our estimations).
- tip: average incubation period (equals 5.75 days in our study)

- Population density affected very highly the number of COVID-19 infections with a rate of 90%.
- Climatic conditions (wind speed) contribute slightly in reducing the number of daily infected cases by an approximate rate of 10%.

$$\begin{cases} \frac{dS}{dt} = -(a+\gamma)S(t-t_{ip}).I(t-t_{ip}) \\ \frac{dI}{dt} = (a+\gamma)S(t-t_{ip}).I(t-t_{ip}) - (b+\gamma)I(t) \\ \frac{dR}{dt} = (b+\gamma)I\,(t) \end{cases}$$

$$\begin{cases} if\ S > \frac{a+\gamma}{b+\gamma}\ \ so\ \ \frac{dI}{dt} > 0 \\ if\ S < \frac{a}{b}\ \ so\ \ \frac{dI}{dt} < 0 \end{cases}$$

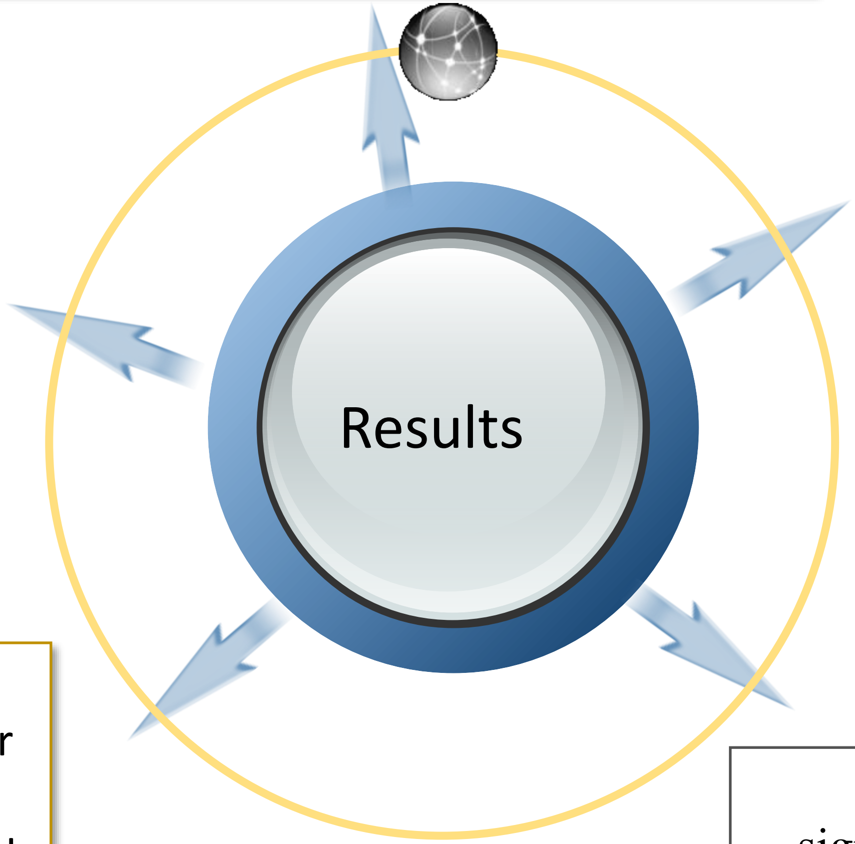
- γ is the proportion in which climatic conditions contribute in reducing the number of susceptibles then infections.
- The population density factor affects the evolution of infections by 90%, while the climatic parameters affects it by only 10%, so γ < a, then, we estimated that $\gamma \simeq \frac{a}{9}$.


Casablanca
NewYork
Madrid
Lombardy-Milan
Paris
Wuhan
proportions
Time(days)
S(t):Susceptibles ('S-I-R Model')
SS(t):Susceptibles('Estimated model')
I(t):Infected cases('S-I-R Model')
II(t):Infected cases('Estimated model')

Conclusion

The temperature, the humidity and the altitude parameters have no impact on daily number of COVID-19 infections

Perspective: The results give serious thought to a special ventilation system in buildings and hospitals to reduce contamination by COVID-19



For an average wind speed greater than ***25km/h***, the number of COVID-19 infections is slightly decreased with a rate of **10%.**

The estimated mathematical model showed that the number of daily susceptibles and infections has slightly decreased compared to presented S-I-R model.

Population density has a significant impact on the daily COVID-19 spread with a rate of **90%.**

Thank you for your attention

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