Air Quality During COVID-19 Pandemic

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Problem Definition

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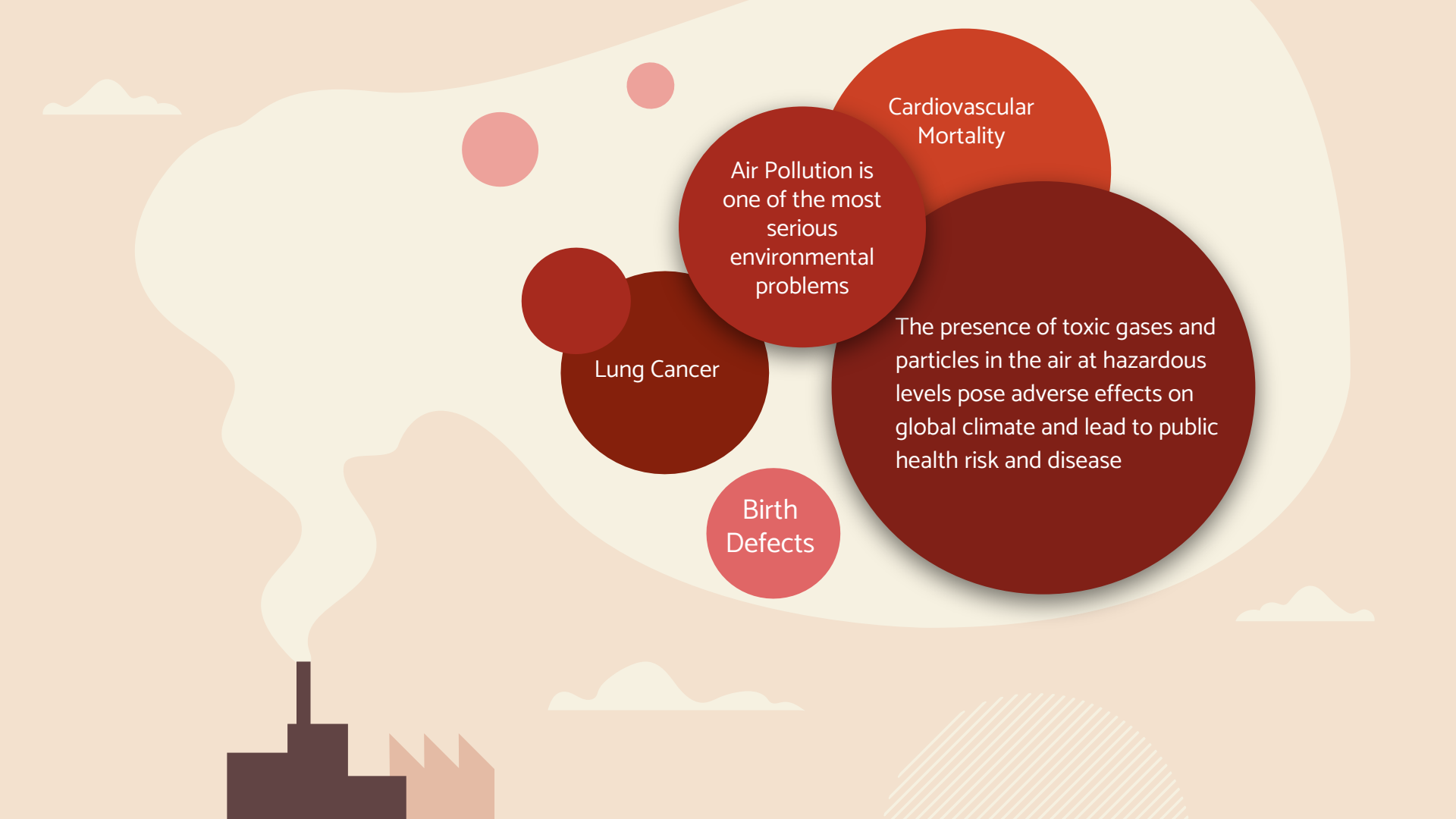
Cardiovascular Mortality
Air Pollution is one of the most serious environmental problems
Lung Cancer
The presence of toxic gases and particles in the air at hazardous levels pose adverse effects on global climate and lead to public health risk and disease
Birth Defects

Where do air pollutants come from?

Natural Sources

Wildfires, volcanoes...

Boston 7/26/2021

(Robin Lubbock/WBUR)

Human Activities

Mobile source: cars, buses, planes...

Stationary sources : Industrial factories, power plants, wooding burning fireplaces...

Pollutant	Sources	Effects
Ozone	Formed when NO (from burning gasoline, coal, or other fossil fuels) and volatile organic compounds mix (from factories and trees) in sunlight.	Leading to more frequent asthma attacks, sore throats, coughs, and breathing difficulty and even premature death; Hurting plants and crops.
CO	Formed when engines burn fossil fuels.	Hard for body parts to get the oxygen; Causing dizzy, tired and headaches; Causing heart disease when exposed to high concentrations of CO.
NO_x	From power plants and cars: Burning fuels; N_2 in the air reacting with O_2 at very high temperatures.	Causing coughs and short of breath when exposed in high concentration; Higher chance of getting respiratory infections; Can form acid rain and harm plants and animals.
Particulate matter	Coarse particles: road dust, sea spray, and construction; Fine particles: when fuel is burned in automobiles and power plants.	Entering the lungs and causing more frequent asthma attacks, respiratory problems and premature death.
SO_2	Mostly from the burning of coal or oil in power plants and chemicals, paper, or fuel factories.	Making people more difficult to breathe; Irritation to people's eyes, noses, and throats; Harming trees and crops, damage buildings; visibility reduction.
Lead	Lead paint, Lead in old pipes, leaded gasoline, power plants and other industrial sources.	Leading to lower IQs and kidney problems for small children; Increasing the chance of having heart attacks or strokes for adults.
Toxic air pollutants	Asbestos and formaldehyde: building materials; Many toxic air pollutants can also enter the food and water supplies.	Causing cancer and birth defects; Skin and eye irritation and breathing problems.
Stratospheric ozone depleter	CFCs: air conditioners and refrigerators; aerosol cans and fire extinguishers; solvents in industry.	More ultraviolet radiation and leading to skin cancer and eye problems; Harming plants and animals.
Greenhouse gases (CO_2, methane, and N_2O).	CO_2: burning of fossil fuels in cars, power plants, houses, and industry. Methane: processing of fossil fuels, natural sources like cows and rice paddies. N_2O: industrial sources and decaying plants.	Global climate change: More temperature extremes, higher sea levels, changes in forest composition, and damage to land near the coast. Human health might be affected by diseases that are related to temperature or by damage to land and water.

Robert L. McConnell, Daniel C. Abel. Burlington, MA : Jones & Bartlett Learning, c2015.: 2013; pp 597-598.

Project Objectives

- Air quality in the past two years
- How the air quality was impacted in countries and cities where the coronavirus was prevalent

2019 — **COVID-19** — **2020**

Reduction of human activities

Data Source

- worldwide air quality data for Year 2019 and 2020 from the Air Quality Open Data Platform (https://aqicn.org/data-platform/covid19/)

- data with geographic location information (https://aqicn.org/data-platform/covid19/airquality-covid19-cities.json)

Preview of Dataset

	Date	Country	City	lat	lon	pop	Parameter	count	min	max	median	variance
0	2020-07-08	NP	Biratnagar	26.45505	87.27007	182324	pm1	16	18.0	198.0	27.0	18671.30
1	2020-02-10	HK	Hong Kong	22.27832	114.17469	7012738	uvi	165	0.1	2.5	0.9	9.49
2	2020-08-24	HK	Hong Kong	22.27832	114.17469	7012738	uvi	195	0.1	10.0	3.7	130.76
3	2020-06-26	NP	Kathmandu	27.70169	85.32060	1442271	pm1	85	8.0	58.0	25.0	1556.39
4	2020-09-28	NP	Kathmandu	27.70169	85.32060	1442271	pm1	90	22.0	96.0	56.0	2270.48
5	2020-02-25	HK	Hong Kong	22.27832	114.17469	7012738	uvi	180	0.1	7.7	1.5	60.24
6	2020-03-15	PR	San Juan	18.46633	-66.10572	418140	aqi	2	22.0	22.0	22.0	0.00
7	2020-06-09	MO	Macau	22.20056	113.54611	520400	uvi	54	-1.0	-1.0	-1.0	0.00
8	2019-11-13	NP	Biratnagar	26.45505	87.27007	182324	pm1	10	45.0	153.0	53.0	18409.30
9	2019-01-10	HK	Hong Kong	22.27832	114.17469	7012738	uvi	140	0.1	4.0	1.0	15.39

Reference Data Source

- National Ambient Air Quality Standards Table (https://www.epa.gov/criteria-air-pollutants/naaqs-table)
- AQI basics (https://www.airnow.gov/aqi/aqi-basics/)

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

What are the most prevalent pollutants ?

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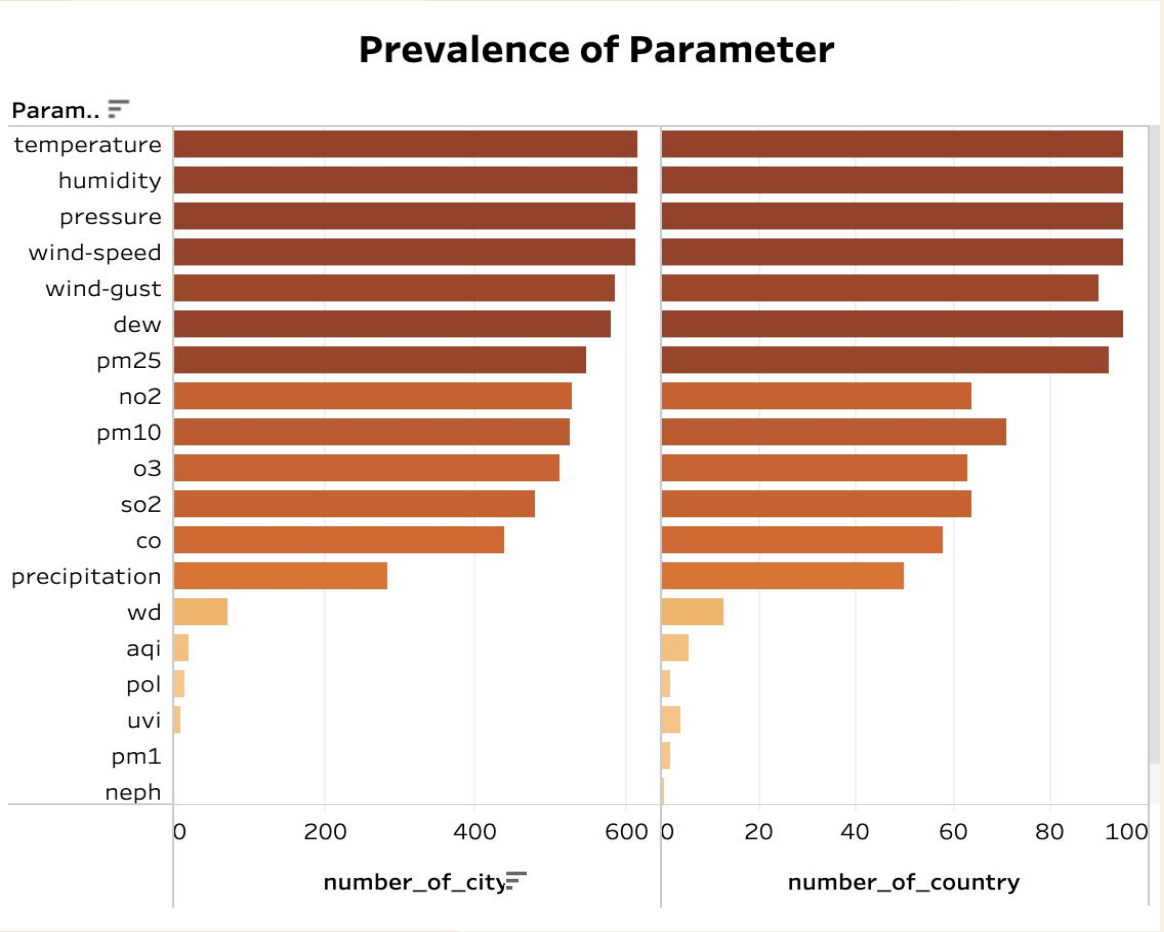

- PM2.5
- NO2
- PM10
- O3
- SO2
- CO
- PM1

Pollutant Levels in 2019 and 2020

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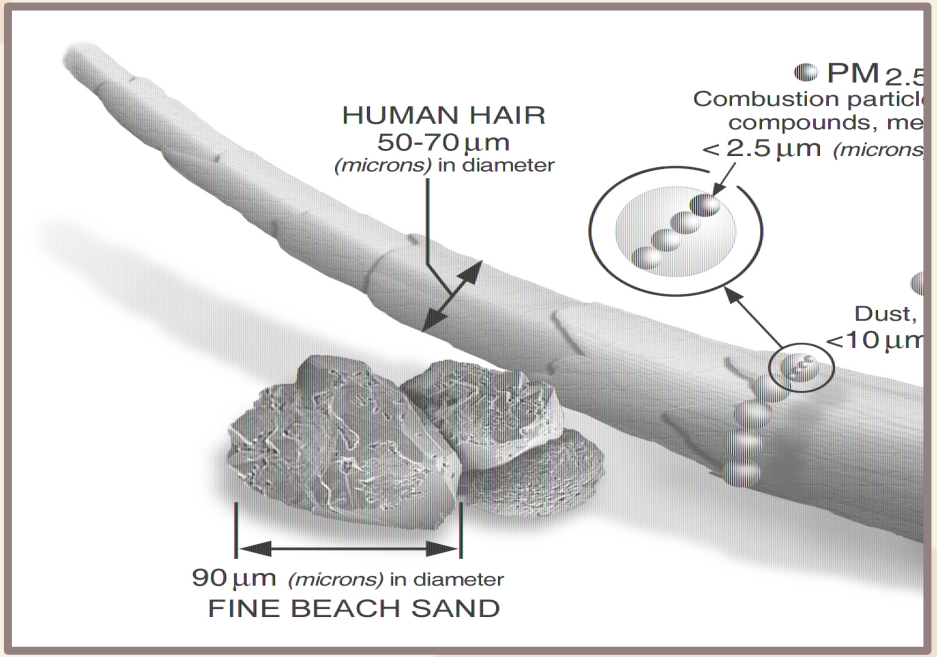
Filtering Parameters

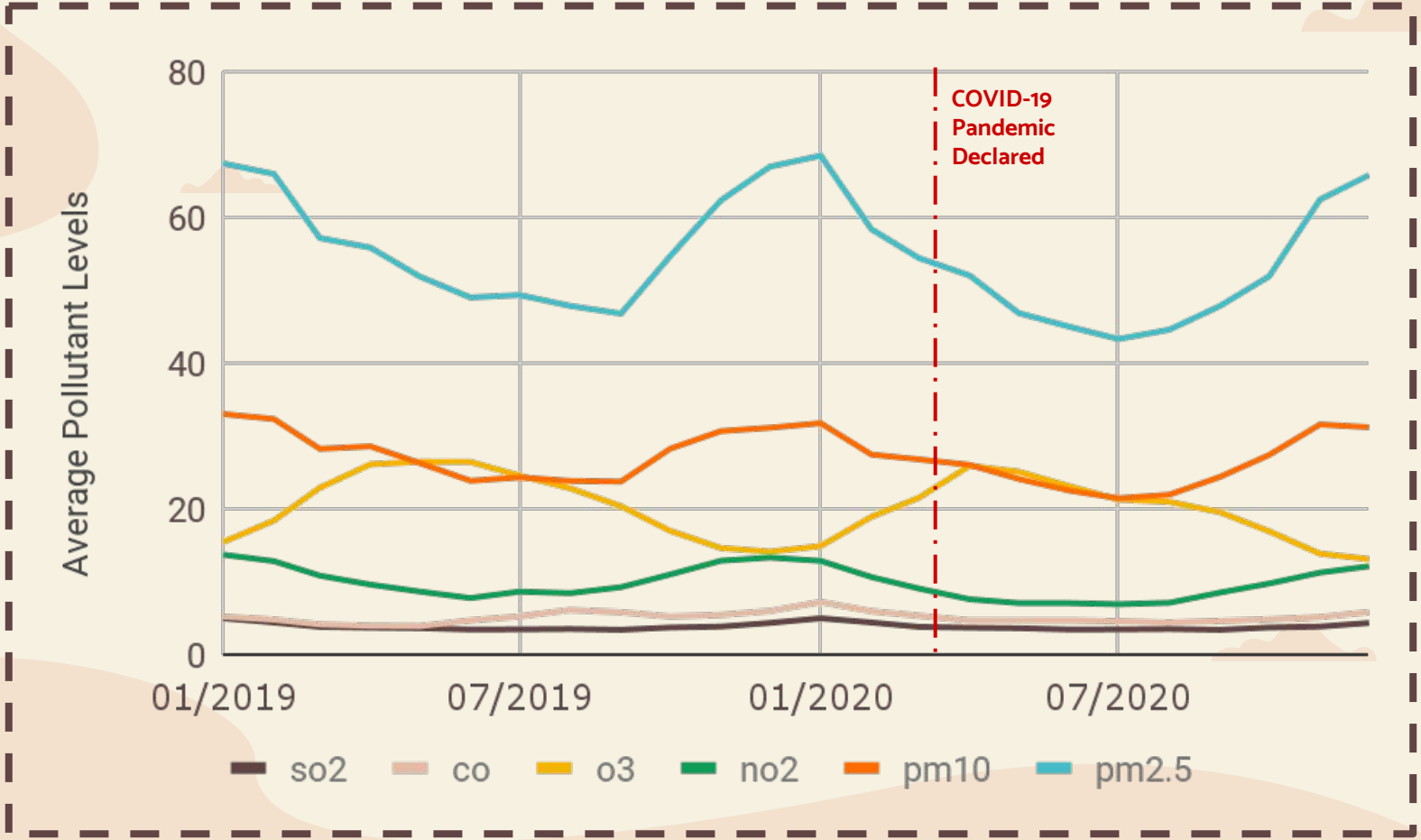
EPA Criteria

- Only want Air Pollutants
  - PM2.5
  - PM10
  - NO2 (Nitrogen Dioxide)
  - O3 (Ozone)
  - SO2 (Sulphur Dioxide)
  - CO (Carbon Monoxide)
- Remove meteorological data



Source: US EPA

Global Average Pollutant Levels 2019-2020



Cities Where Air Quality Changes the Most

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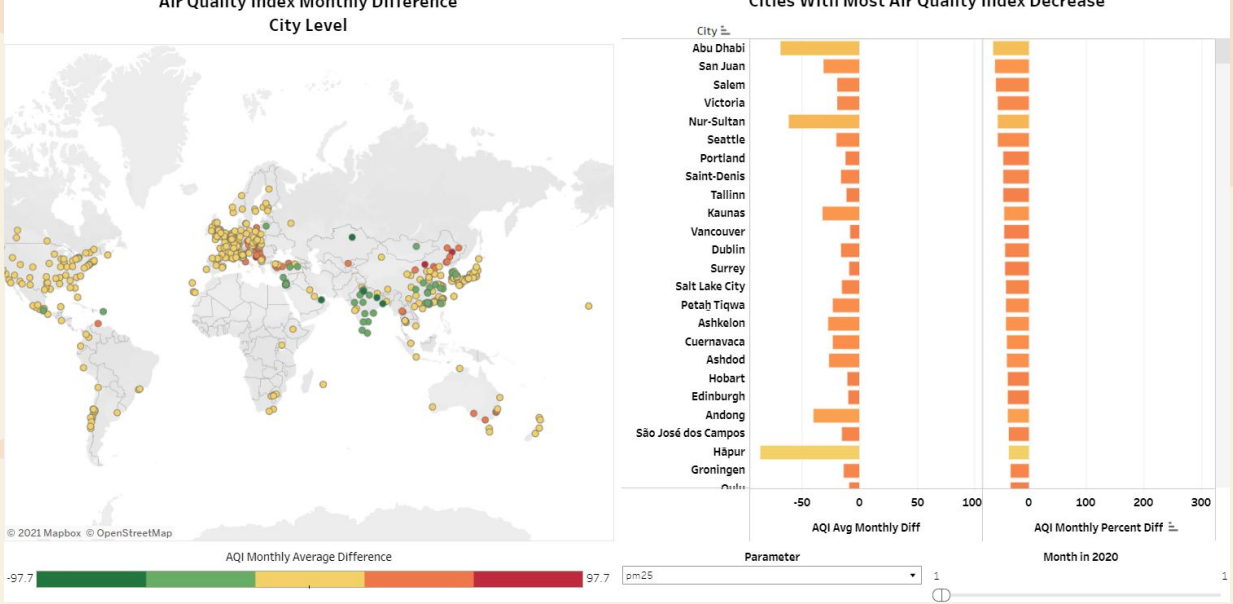

During the pandemic, cities getting most air qualities improvements in terms of percent AQI differences for each pollutant are:

- CO: United States Portland, Chile Talca and Mexico Aguascalientes;
- NO2: Iran Qom, South Africa Middelburg and Philippines Butuan;
- SO2: Greece Athens, Mexico Mérida and Mexico San Luis Potosí;
- Ozone: Mexico Aguascalientes, United States Queens and United States The Bronx;
- PM 10: India Gandhinagar, China Hohhot and Israel Tel Aviv;
- PM 2.5: Mexico Mérida, Tajikistan Dushanbe, Bosnia and Herzegovina Sarajevo, Turkey Erzurum, China Qiqihar and India Gandhinagar;

City	Country	Parameter	num_month_mt_50_per_decrease
Portland	US	co	3
Qom	IR	no2	5
Shiraz	IR	no2	4
Khorramabad	IR	no2	3
Kayseri	TR	no2	3
Sivas	TR	no2	1
Butuan	PH	no2	1
Aguascalientes	MX	o3	5
Brooklyn	US	o3	4
The Bronx	US	o3	2

Cities getting at least 50% and 50 AQI reduction for longest period:

- CO: United States Portland, 3 out of 12 months;
- NO2: Iran Qom, 5 out of 12 months;
- O3: Mexico Aguascalientes, 5 out of 12 months;
- PM10: India Gandhinagar and Bhopal, 2 out of 12 months;
- SO2: Mexico Mérida 5 out of 12 months;
- PM2.5: several cities including Iran Kermanshah, Singapore Singapore, AU Sydney and Canberra, 1 out of 12 months;

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Regression Analysis

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Regression analysis on
COVID-19 cases and pollutant
Air Quality Index Globally

Determining X and Y

Y X

Row	month	month_n	country	parameter	diff_avg	diff_perc	confirmed	country_name
1	May	5	AE	o3	9.45	0.82245430809399489	22154	United Arab Emirates
2	May	5	AE	pm25	-47.58	-0.34061135371179041	22154	United Arab Emirates
3	May	5	AR	co	3.11	3.2736842105263153	12931	Argentina
4	May	5	AR	o3	-2.89	-0.32878270762229794	12931	Argentina
5	May	5	AR	no2	1.31	0.17702702702702708	12931	Argentina
6	May	5	AR	pm25	12.25	0.32347504621072093	12931	Argentina
7	May	5	AT	co	0.0	0.0	1130	Austria
8	May	5	AT	no2	-2.36	-0.27251732101616633	1130	Austria

Filter by

R^2 Results for Other Parameter

0.0049

CO

-0.0003

O3

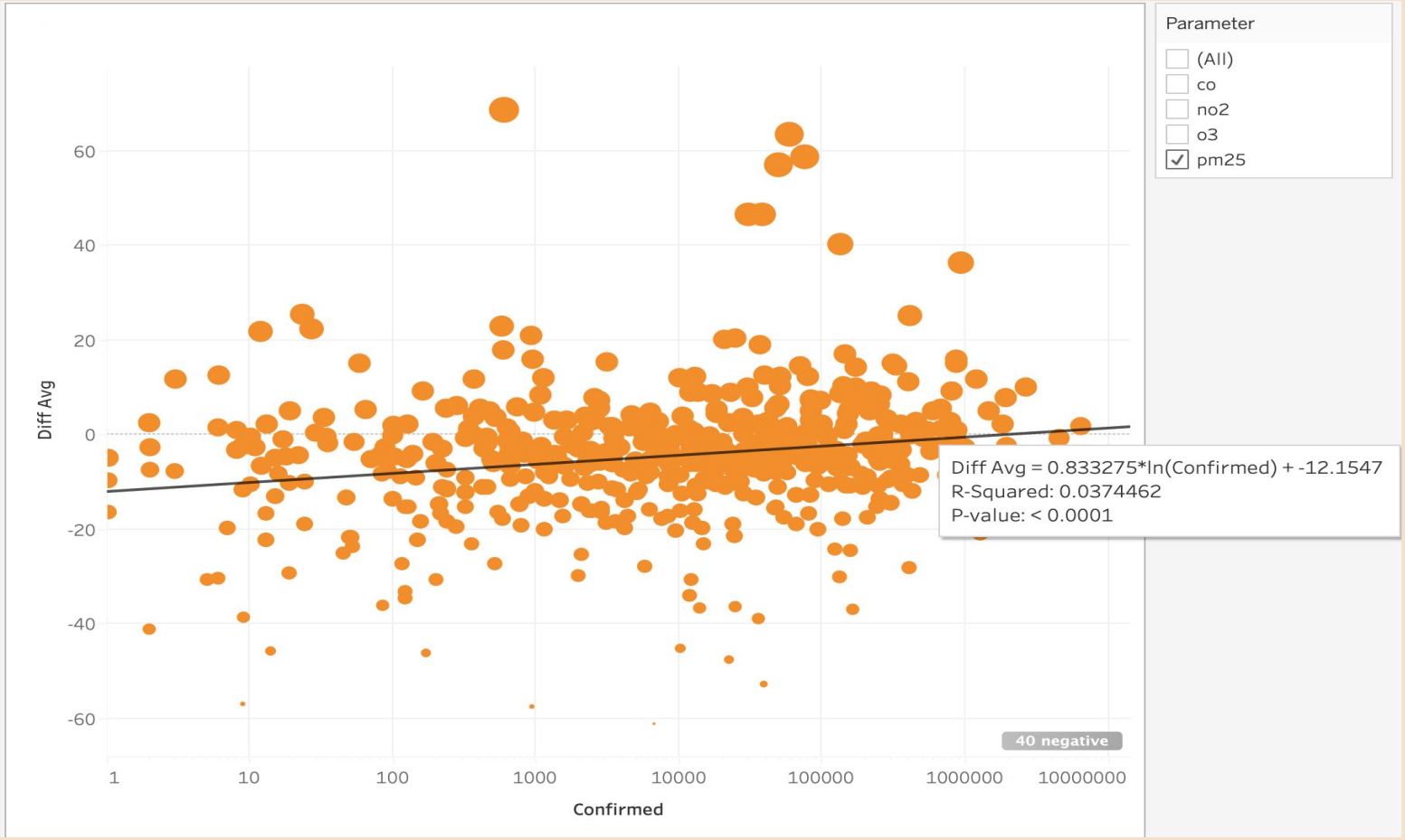
0.0003

NO2

0.0029

PM2.5

Using Tableau to do the log regression



Lockdown Periods

China City of Wuhan declares 76-Day Lockdown

Jan 23, 2020

March 9, 2020

Italy Government imposes nationwide lockdown

Australia Government declares no travel policy and no indoor gathering of more than 100 people

March 18, 2020

March 19, 2020

USA California declares first stay-at-home order

New Zealand Declares state of emergency and goes into lockdown at midnight

March 25, 2020

April 7, 2020

USA South Carolina declares stay-at-home order (last state to do so)

China Wuhan lifts 76-day lockdown

April 8, 2020

May 18, 2020

Italy Government eases lockdown restrictions

Most countries except USA have eased/are easing lockdown restrictions

May - June, 2020

Change in Air Quality

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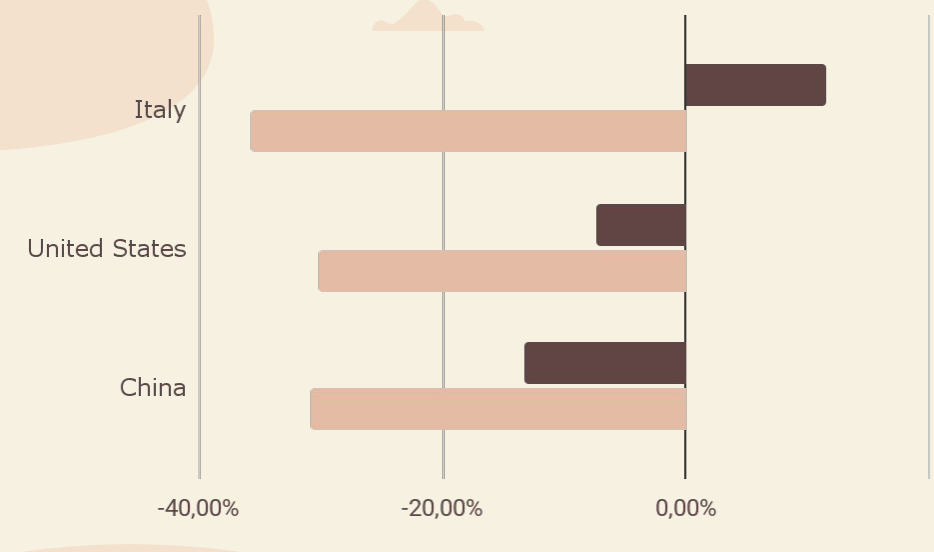
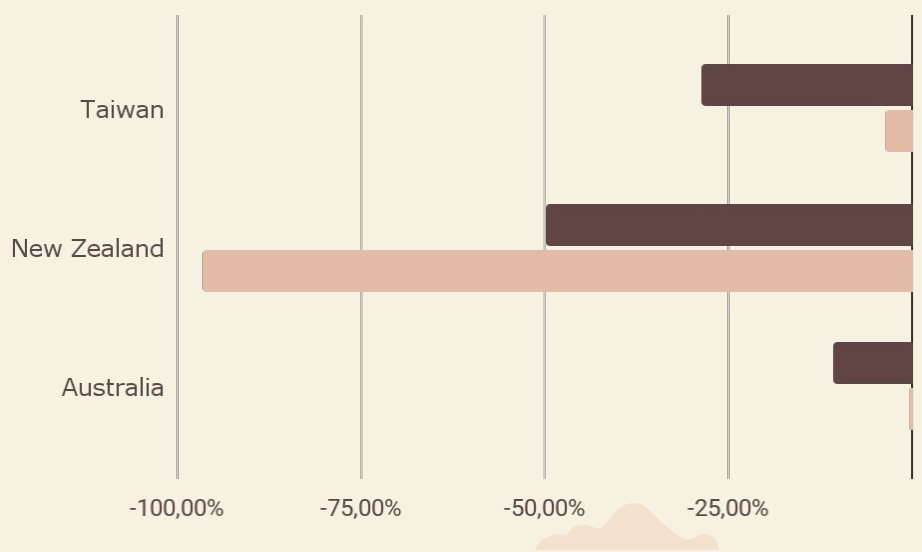
Changes in Air Quality from 2019 to 2020, in countries with high and low COVID-19 cases.

Changes in Pm2.5 and No2 Levels



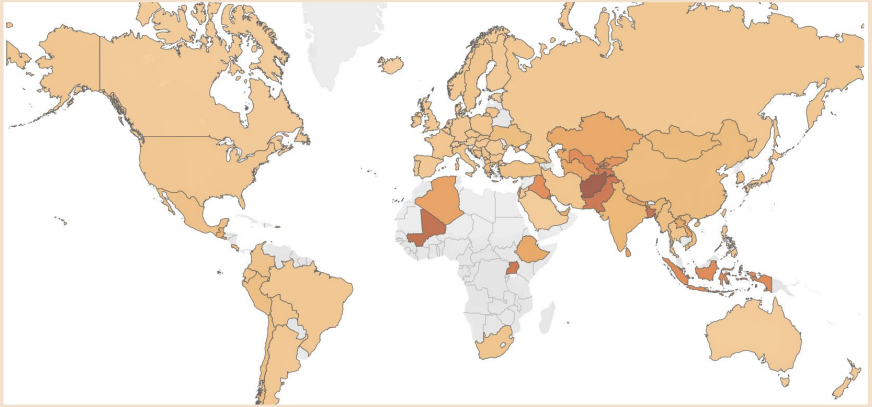
Countries with high COVID-19 cases



Countries with low COVID-19 cases

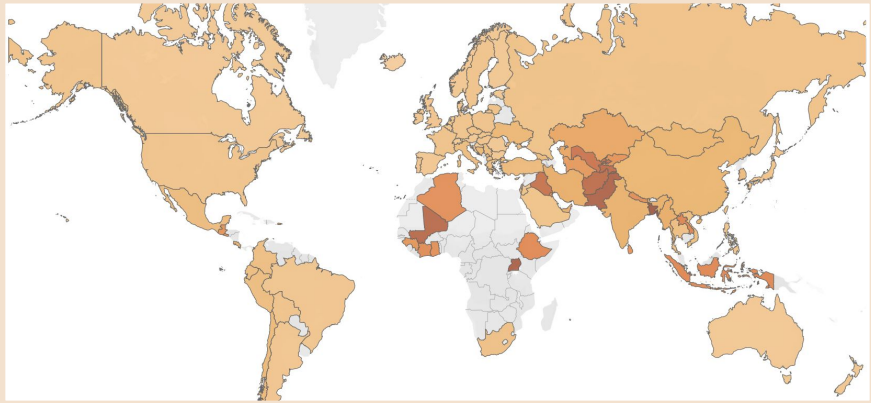
Pm2.5 NO2

2019-2020 Changes in Pollution



2019

2020



Conclusion

THANKS!

Do you have any questions?

Visit our dashboard: Analyzing Air Quality During COVID19 Pandemic

Using Tableau to do the log regression