



Air Pollution in Texas: Locked down by COVID-19

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Importance of monitoring Air Quality and its relation to public health

- Air is one of the critical natural resources that is vital for human health.
- In the United States, poor air quality is the cause of around 60,000 premature deaths annually and over \$150 billion in costs related to air pollution-driven illnesses (NOAA and EPA)
- Air pollutants emitted from vehicles and industries may also affect the transmission of viral infection and increase the number of hospital admissions due to bronchiolitis and asthma (Sarmadi et al., Carugno et al., 2018; Glencross et al., 2020; Groulx et al., 2018; Nenna et al., 2017).
- This emphasizes the importance of monitoring air quality in order to control and lower the pollution levels.



Analyzing anthropogenic emissions using satellite data

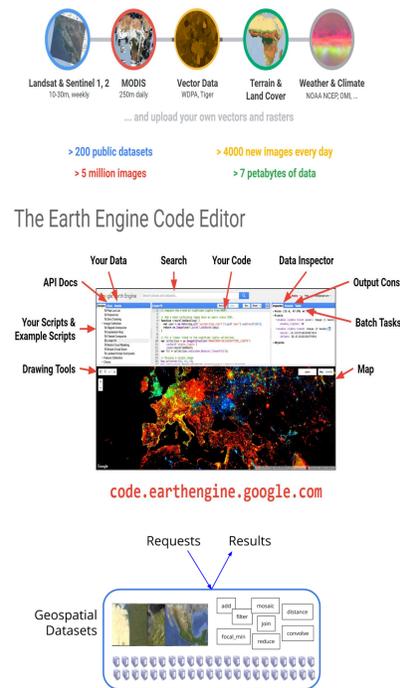
- Although ground measurements are considered the most accurate, this approach has two major weaknesses:
 - apart from being expensive these monitors are also sparsely and unevenly distributed in space. U.S. has the most extensive monitoring network in the world, but its stations are located in only 30% of the counties.



- the limited coverage of ground monitors restricts epidemiological studies to areas near monitoring sites; approximately 30% of the U.S. population lives in suburban and rural counties without any coverage.
- Satellites also provide data on air quality and are able to fill the spatial gaps of ground monitoring stations.
- Burning fossil fuels directly emits a lot of nitric oxide which is rapidly converted into nitrogen dioxide (NO2) in the atmosphere.
- NO2 has a short lifetime, which means it is detected near its source and often considered as a useful proxy for human activities.
- NO2 can easily be measured by satellite. In this study the spatial distribution of tropospheric NO2 was derived using the European Space Agency's (ESA) Sentinel-5 Precursor (S5P) satellite data available through TROPospheric Monitoring Instrument (TROPOMI).

Google Earth Engine (GEE): an open source geospatial analysis platform

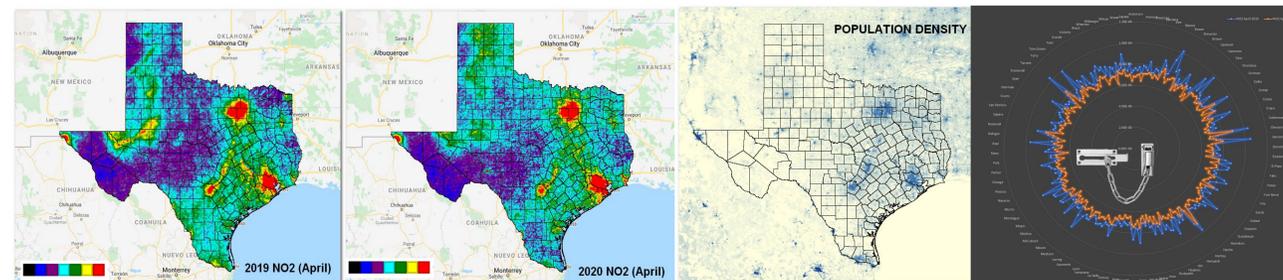
- GEE is a cloud-based platform for planetary-scale geospatial analysis.
- Datasets:** A petabyte-scale archive of publicly available remotely sensed imagery and other data.
- Compute power:** Google's computational infrastructure optimized for parallel processing of geospatial data. No more downloading and analyzing individual files.
- Upload your own data:** You can upload raster & vector data to the platform.
- Code Editor:** An online Integrated Development Environment (IDE) for rapid prototyping and visualization of complex spatial analyses.
- Version Control:** GEE will back up on your code in a git repository and you can share those repositories with other users.



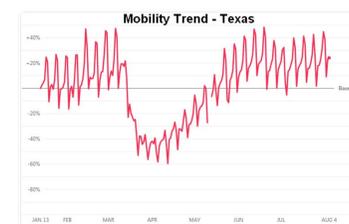
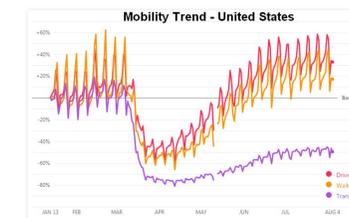
- Scripts tab (Git repository and examples to help get started)
- Docs tab (API reference docs)
- Assets tab (upload your own data)
- Inspector tab (query the layers on the map),
- Console tab (messages),
- Tasks tab (execute long running tasks),
- Code Editor (for JavaScript, but there's also a Python API),
- Map (including layer tools, geometry tools, etc.
- Get Link button (send it to your friends!),
- Search bar, Help button.



Results



- We examined the spatial correspondence between population density and NO2 concentrations – it is evident that the high population concentration areas such as Dallas, Houston, Austin and San Antonio have a direct spatial correspondence with high NO2 concentration areas.
- The side by side comparative maps and the county wise chart plotted using data exported from GEE demonstrates an improvement in air quality in the absence of typical emissions from transportation and other sources during the lockdown period.
- We also leveraged Apple mobility trend data* to find an empirical evidence for a link between reduction in traffic-induced pollution and a decline in ambient NO2 exposure during the lockdown period.
- We can see a huge dip in mobility trend for the month of April for Texas as well as for the US.

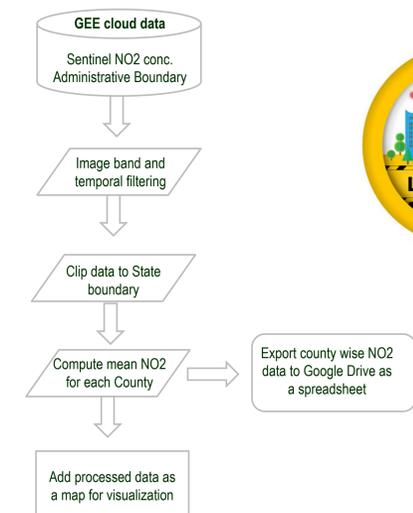


* this data is based on location data of Apple's map services and is generated by counting users' requests for directions in the app.

<https://www.apple.com/covid19/mobility>

Examining the air quality status during COVID-19 lockdown

- The rising number of fatalities and adverse effects of COVID-19 on human health have led governments to take strict lockdown measures leading to improvement in air quality in many areas.
- In this study we examined changes in the concentration of NO2 within the lockdown period and compared it to the 2019 baseline data for the state of Texas.
- We utilized freely available datasets and ran our analysis using Google Earth Engine (GEE), a cloud based and an open source geospatial analysis platform.
- We wrote a script to retrieve NO2 data, calculate mean pollution levels per county, and to plot a map for visualizing NO2 data across time.
- Tropospheric NO2 satellite data is provided as a daily column number density (mol/m2) which has a good agreement compared to ground observations (Theys and Wagner 2019, Eskes and Eichmann 2019).



References

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- <https://www.weather.gov/safety/airquality>
- <https://medium.com/google-earth/monitoring-air-quality-with-s5p-tropomi-data-4f6b0aeb1c0>
- <https://earth.gizmodo.com/coronavirus-slashes-global-air-pollution-interactive-m-1842473790>

Martier, M. E., J. Xing, Y. Zhu and S. Wang (2020). "Impacts of COVID-19 response actions on air quality in China." Environmental Research Communications.