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# COVID-19 Blog — Urban Systems Lab

The Potential Impacts of COVID-19 on the Urban Cooling Effect in New York City

35-45 minutes



As communities worldwide respond to the COVID-19 crisis, the Urban Systems Lab team stands in solidarity with frontline responders, those most affected, and communities working to help those most in need.

With our resilience tested, the USL will be providing resources and new analysis on potential impacts of COVID-19 on vulnerable communities in NYC, and the interdependent risks of COVID-19 and climate. We will update this page regularly including key <u>research</u>, <u>datasets</u>, <u>and relevant articles</u> that may be important to stay informed of during this ongoing crisis. We hope this will provide a useful resource to visualize how to understand multiple dimensions of how COVID-19 may impact communities and so that we can share strategies, actions, and nurture hope in a time of uncertainty.

#### August 25, 2020

# New Article on Urban Green Space Use during COVID-19 in NYC

**Figure**. Variation in responses about the importance of parks and open space for mental (A,B) and physical (C,D) health across gender (A,C) and race/ethnicity (B,D) groups.



The USL research team, Bianca Lopez, Chris Kennedy and Timon McPhearson developed a new pre-print article, Parks are Critical Urban Infrastructure: Perception and Use of Urban Green Spaces in NYC During COVID-19, exploring the results of a social survey launched during the early months of the Covid-19 pandemic in NYC. Working with partners at <u>Building</u> <u>Healthy Communities NYC</u>, <u>The New York State Health</u> <u>Foundation</u>, and <u>The Nature Conservancy</u>, the study examines the impact of COVID-19 on the perception and use of urban green spaces in New York City. The results support anecdotal evidence of shifts in park use, and the real controversy of who can benefit from parks in NYC, historically, but also during COVID. Overall we found access to urban green spaces during COVID-19 is not equal despite being more important now for physical and mental health than before the pandemic. We also found key differences between the concerns and needs of different populations, with Black communities expressing additional concerns over policing and racial profiling, and indications that low income and communities of color do not have access to larger parks of quality, and thus reducing their use and perceived access. Read the pre-print to learn more.

#### July 27, 2020

# Hydrant Hand Washing Retrofit Prototype

USL Faculty Fellow <u>Chris Woebken</u> is working on a small hand washing hydrant retrofit prototype developed with the hydrants working group in collaboration with Tei Carpenter, Beyond Plastics at Bennington College, RETI Center and Pioneer Works in Brooklyn, NY. A prototype is now installed on two hydrants along Cool Streets in Red Hook, Brooklyn. This minimal prototype extends the New Public Hydrants research from the most low cost and utilitarian perspective (\$40 per retrofit). Next step is to fabricate a nice industrial soap mount and attach it to the bollard. Video by Theo Stewart-Stand.

#### JULY 23, 2020

# Urban Systems Lab Joins the NYC Mayor's Office Recovery Data Partnership

The Urban Systems Lab joins the <u>NYC Mayors Office</u> <u>Recovery Data Partnership</u> to share data with the City to aid in COVID-19 response and recovery efforts. The USL will be sharing data from our social survey, "Perception and Use of Urban Parks and Open Space During COVID-19 Social Distancing in New York City", which explores among other things access and use of urban parks and open spaces in NYC during COVID-19.  $\rightarrow$ 

June 18, 2020

# Extreme Heat, COVID, and Equity in NYC

The National Oceanic and Atmospheric Administration (NOAA) is forecasting an unusually warm summer in the US for 2020. In New York City, this could exacerbate heat exposure in homes, where most heat-related mortality occurs, as well as potential brownouts or blackouts due to extreme weather.

What will potential heatwaves, blackouts, and brownouts mean for city residents already struggling with lack of air conditioning and limited access to green spaces? How will existing health, weather, and economic hazards be affected by new guidelines designed to reduce COVID-19 outbreaks in NYC? What are just and equitable solutions to address threats posed by extreme heat and other interdependent risks? The USL participated in a <u>Cary Institute</u> science conversation featuring Emily Nobel Maxwell, Director of The Nature Conservancy's Cities Program in New York, Christian Braneon, a Remote Sensing Specialist at the NASA Goddard Institute for Space Studies, Annel Hernandez, Associate Director of the NYC Environmental Justice Alliance, and Timon McPhearson, Director of the Urban Systems Lab (The New School) and a Cary Institute Senior Research Fellow. Take a look at the video above to see the full presentation and <u>click here</u> for additional resources.

#### June 15, 2020

# **Urban Parks and Open Spaces during COVID-19**





The Urban Systems Lab is analyzing data collected through a social <u>survey</u> on the importance of urban parks, open space, and other green spaces during the COVID-19 crisis in the United States. The aim is to understand how people are using these spaces during the pandemic and how this may affect mental and physical wellbeing.

May 14, 2020

# **COVID-19 and Housing Precarity**



USL researchers have conducted new analyses that identifies strong relationships between housing precarity (defined as eviction rates, rent burden, and crowding) and vulnerability to Covid-19. The team looked at variables such as Forced Displacement, Rent Burden and Crowding through the lens of contextual vulnerability. To read more of their analysis <u>click</u> <u>here</u>.



Monthly eviction totals for all of New York City from Jan 2017 to April 2020.

#### May 4, 2020

# Weekly air pollution (mean NO2) from February through April 2020

USL Researchers have noticed a notable decrease in weekly air pollution since the second week of March 2020. However, some weeks in March and April showed high NO2 level (but less than February and early weeks of March before stay-athome orders). This indicates that we should not give full credit for the reduction in air pollution to the shutdown. Significant days of rain in March and April have made it difficult to show a significant relationship between stay-at-home orders and the cleaner air. (Data source: Sentinel-5P) Developed by Ahmed Mustafa.

April 21, 2020

# Social Vulnerability Indicators Predict Inequity in NYC COVID Cases

The Urban Systems Lab team is analyzing a range of key social vulnerability indicators against cumulative percentage of tests with a positive result per zip code in New York City. The results, shown below, highlight the class and <u>racial inequities</u> of the pandemic, which are <u>impacting communities of color</u> and frontline responders disproportionately. The data released by the NYC Department of Health, <u>broken down by zip code</u>, shows 34% of COVID-19 deaths were Hispanic, 28% African American and Black, 27% White, and 7% Asian. Shaded areas represent the 95% confidence intervals.

Data from the <u>NYC Department of Health's Github</u> and the <u>American Community Survey (2017)</u>.

#### April 20, 2020

# Mobility of NYC Residents Under Social Distancing

**Figures** show the spatial distributions of geo-located tweets between April 1 through April 15 in NYC. The density of tweets

roughly represents the population density in the city. Percentage of geo-tweets (from April 1 through April 15) per land-use which can be used to track locations of human activity during the COVID-19 crisis as it evolves. Over 60% of collected tweets were received from residential-related uses, confirming a strong impact on human behavior of shelter-inplace orders. The differences across weekdays and weekends in activities that occurred within urban green & open spaces are marginal with an average of 8.2% of tweets during weekdays VS an average of 9.1% during weekends. The figure shows that the shelter-in-place and social distancing orders appear to be observed regardless of the day, with regular patterns. Developed by Ahmed Mustafa.

#### April 16, 2020

# Availability and Access to COVID-19 Testing Kits in NYC

As more and more cases from COVID-19 are reported by the thousands, testing kits in New York City are still limited and hard to come by. Given that New York City is in the midst of its most challenging time in this epidemic, it is important to be able to allocate these limited tests in the most efficient and strategic manner. As of April 8th, the number of positive cases ranged from as low as 8 to as high as 1,728 per zip code. Developed by Avigail Vantu using NYC Department of Health and Mental Hygiene data. To read a full analysis and see the top 5 zip codes with the largest number of people testing

positive as of April 8th. click here.

#### April 3, 2020

## **New York City Electric Load**

An analysis of New York City electric load since 2015 is revealing significant reductions which are trending below a 5 year average. This decrease in energy load is important because it essentially means that NYC's energy peaks are driven in large part by office, commercial, and industrial uses. However, electric loads are higher in the summer because of air conditioning use. If we were to give everyone in the city an AC unit for instance, would that affect the total energy use significantly (considering the neighborhoods with the least AC adoption have at ~75% already)? Or would decreasing energy use in the non-residential sector offset more widespread adoption? Overall the <u>Midcontinent Independent System</u> <u>Operator</u> is reporting an 18% reduction in electric load regionally, compared to March 2019.

#### NYC electric load decrease since lockdown







**Figure**: NYC Electric Load 2015 - Present. Electric loads in NYC have lowered since the lockdown order. Data collection and analysis performed on April 1st, 2020 (Electric load data: NYISO; Temperature Data: NOAA).

# NYC Subway Use

As NYC urges residents to shelter in place and social distance, New York's mass transit system has been impacted in different ways. According to the MTA subway ridership has hit historic lows (down 87%), and worker shortages have cut service on some lines such as the B, W, 7, J and Z. However ridership declines are not uniform across the 5 boroughs, highlighting equity, access, and socio-economic issues. In low-income neighborhoods ridership is more consistent with data from this time last year, with reports of overcrowding as service is disrupted. The USL's analysis examines data on daily entries registered by the city's turnstiles, which can be used to track some of the behavioral changes that COVID-19 has triggered as cases escalated.



**Figure:** NYC Subway Use (Feb 1 - April 17, 2020). Source: <u>MTA turnstiles traffic data</u> and <u>NYC Health Github</u>

**Figure**: MTA Subway ridership scatterplots showing distribution based on Median income, % Below Poverty and % Uninsured.

#### March 2020

As the world responds to the ongoing COVID-19 pandemic, a need to understand the dimensions of social vulnerability is

key in both addressing the crisis long-term but to also consider other ongoing challenges related to climate change, urban development, and equity. At the Urban Systems Lab, our work has often considered who is most at risk when considering a range of ongoing hazards and threats from extreme heat and weather, to flooding and damage to vital infrastructure.

Similar to issues related to climate change, not everyone who lives in a city will experience the COVID-19 crisis in the same way. Depending on your age, race, ethnicity, income level, proximity to medical resources and key infrastructure, your experience will vary considerably. Additionally, changing behavior including social isolation, sheltering in place, may create additional vulnerabilities and challenges for the wellbeing of residents. Planning and related governance processes can be intentionally or unintentionally exclusionary in this respect, alienating minority and marginalized groups from decision-making that address the real needs of vulnerable communities.

## Visualizing Who is Most Affected and Where

In prior <u>CDC reports</u>, data has shown that "nearly 40 percent of patients sick enough to be hospitalized were ages 20 to 54." The fatality rate however is highest amongst those aged 85 or more, which ranges from 10% to 27%, followed by 3% to 11% among persons aged 65–84 years, 1% to 3% among persons aged 55-64 years, <1% among persons aged 20–54 years, and no fatalities among persons aged  $\leq$ 19 years. In more recent data from the <u>New York City Department Department of</u>

Health, older groups make up most of the city's hospitalizations and deaths with 42% of coronavirus patients hospitalized in New York City so far, 65 or older. About 9% of the patients in the 18-44 age group had to be hospitalized, compared to 22% of patients 45-64, 36% of patients 65-74, and half of those 75 and over. That's similar to the nationwide portion with approximately 45% of US hospitalizations the 65 or older age group.

Although New York has been characterized as the "epicenter" of the COVID-19 outbreak, <u>new research</u> from <u>The Marron</u> <u>Institute of Urban Management</u>, New York University describes cities like New York, LA, San Francisco and Seattle as the "**vanguard**" on the pandemic front. Their research looks at metropolitan areas (MSAs) as a function of its population and density, and to a lesser extent as their role as a gateway to the world. They hypothesize that metropolitan areas are reporting more infections because they tend to be the locations for the onset of infection earlier on in the spread, and because more testing is occurring per capita. They also explain many urban centers have a large share of population over 75 years of age and the share of the population living at high density.

Population density plays a key role here, especially in New York which is the largest city in the United States with about 8.5 million people in 2016, according to the U.S. Census Bureau, and the largest also in terms of economic activity (with the metropolitan area home to approximately 23.6 million people). According to the <u>NYC Department of Planning</u>, "New York has the highest population density of any major city in the United States, with over 27,000 people per square mile," and accounts for over 40% of the entire population of New York State. Although population density is one important factor, there are several other issues related to equity, social vulnerability and climate that the USL is analyzing. Below are brief summaries of some of NYC's most vulnerable communities - lease <u>get in touch</u> if you have data or suggestions for more analysis to include.

# POPULATION DENSITY Data Source: American Community Survey (2018)



**Figure 3.** NYC Population Density. Source: American Community Survey (ACS) 2018.

# Uninsured Individuals and Access to Health Care

According to the NYC Department of Health and Mental Hygiene, there were about 615,000 uninsured New Yorkers in 2017, roughly 7 percent of the city's population (U.S. Census Bureau). Among city residents who were not U.S. citizens about 300,000, or nearly 22 percent, were uninsured—and the rate was likely even higher among noncitizens who were undocumented.

Queens Community District 7, which includes the neighborhoods of Flushing, Murray Hill, and Whitestone, had an uninsured rate of 15.5 percent in 2017, the highest in the city. Yet there are no public hospital facilities in the district. Likewise, Brooklyn Community District 7 (Sunset Park and Windsor Terrace) had an uninsured rate of 12.4 percent and no public hospital facilities in proximity. Neighborhoods, such as Queens Community Districts 3 (Jackson Heights and North Corona) and 4 (Elmhurst and South Corona), with comparatively high shares of uninsured residents as well as nearby public hospital facilities. More than 14 percent of residents in Queens Community Districts 3 and 4 were without insurance. There also were neighborhoods with comparatively low rates of uninsured residents such as Manhattan's Community District 3 (Chinatown and Lower East Side, 6.0 percent uninsured) and Community Districts 1 and 2 in the Bronx (Hunts Point, Longwood, and Melrose; 9.3 percent) served by a number of NYC Health + Hospitals facilities. (<u>New York City</u> <u>Independent Budget Office</u>)



Figure 4. Population in NYC Without Health Insurance.

Source: American Community Survey (2017).

## **Communities Living Below Poverty Line**

Overall the poverty rate is 17.3% (2018 data) citywide, with unemployment at 4.2% as of March 2020 (however, not reflective of recent unemployment filings). The New York City Government Poverty Threshold for 2017 was \$33,562. Although trends show extreme poverty levels have decreased over the past several years, a larger share of New Yorkers — 43.1 percent — was "near poverty" in 2017.

According to the 2018 NYC Community Health Atlas, the Bronx has the highest share of communities living below the poverty line. The neighborhoods that have the highest percent of poverty based on income and necessary expenses is Fordham and University Heights (34%), Highbridge and Concourse (32%), Morrisania and Crotona (31%), Belmont and East Tremont (31%).

The CUNY Graduate School of Public Health & Health Policy (CUNY SPH) is also analyzing job loss rates in NYC. In their initial tracking survey conducted March 20-22 findings show 29% of New York City residents are reporting that either they or someone in their household has lost their job as a result of coronavirus. Job loss is also disproportionately impacting Hispanic and lower income city residents with two in five respondents (41%) saying either they or a household member lost their job in the last two weeks.

Figure 5. Population Below Poverty Line. Source: American

Community Survey (ACS) 2018.

# **Rent Burden**

The Rent Burden, which is a percentage of renter-occupied homes whose gross rent (contract rent plus average monthly cost of utilities including electricity, gas, and water and sewer) is equal to or greater than 30 percent of household income in past 12 months is 51% overall citywide. The neighborhoods of Fordham and University Heights (65%), Borough Park (64%) and Elmhurst and Corona (62%) are the neighborhoods with some of the highest rates of Rent Burden.

# **Energy Burden**

The Energy Burden is the proportion of total household income that goes towards home energy bills, which includes electricity, natural gas, and other heating fuels. According to the <u>American Council for an Energy Efficient Economy</u>, for metropolitan households in the US, the median burden is 3.5%. USL Research Fellow Luis Ortiz has been conducting research on energy burden and its impact on communities in New York City, especially as climate change drives more frequent heat waves and overall temperature increases in urban centers.

As of 2017, heat waves caused the second most weatherrelated fatalities in the United States (National Weather Service, 2015), with 97 directly attributed deaths per year between 2008 and 2017 and 107 in 2017 alone. Studies have shown that majority of heat-related mortality occurs within homes and that the neighborhoods with highest heat-related vulnerability coincide with those with lowest air conditioning adoption (eg. low-income individuals, communities of color and low-income multifamily units). In neighborhoods with highest burden such as the South Bronx and Central Brooklyn, current burden of AC use can reach 5.7% of household income (for a 1000 sq ft/92.9 sq m home).

# The Elderly

In New York City there are approximately 1.4 million elderly, age 60 and older, which constitute 17% of the population, and the proportion is projected to increase to 50% of the population in the next two decades.

According to the 2018 NYC Community Health Atlas, the neighborhoods that have the highest percent of adults ages 65 and older include: Coney Island (22%), Upper East Side (20%), Rego Park and Forest Hills (19%), Riverdale and Fieldston (18%), Throgs Neck and Co-op City (18%).

**Figure 8**. Elderly Population over 65 in NYC. <u>Research</u> on COVID-19 cases show older adults may face the greatest risks to the virus because of a greater prevalence of chronic conditions and weakened immune systems.

# Children and Adults with Asthma

Overall in New York City, about 10 percent of adults are asthmatic, according to the CDC. A combination of air

pollution, mold, dust and asthmatic triggers like pollen and weather fluctuations affect African-American and Latino populations disproportionately. This is often a factor of proximity to large highways like the Major Deegan, the Bruckner, and the Cross Bronx expressways, industrial zones, and inadequate access to health services. According to the <u>American Academy of Allergy Asthma & Immunology</u>, New York City, over 39,000 children under the age of 15 visited the emergency room because of asthma in 2010.

According to a <u>2016 NYC Community Health Profile</u>, the South Bronx neighborhoods of Mott Haven and Melrose had three times as many hospitalizations for asthma as the rest of New York City, and 1.5 as many as the rest of the Bronx. While 0.3 percent of children aged 5 to 14 were hospitalized for asthma in New York City in 2013, 0.7 percent were in the Bronx, and 1.2 percent in Mott Haven and Melrose. In the same year, 0.2 percent of asthmatic adults got hospitalized in New York City, 0.5 percent did in the Bronx, and 0.7 in Mott Haven and Melrose. In Hunts Point and Mott Haven in the Bronx, the asthma hospitalization rate is 12.2 per 1,000 children; in East Harlem it's 11.4. Both are more than double the citywide rate of 5 per 1,000 children.

**Figure 9.** Asthma Rates for Adults in NYC. <u>Recent studies</u> have shown high levels of air pollution and asthma have been linked to larger numbers of people hospitalized with pneumonia. <u>Death rates</u> from asthma, which are also linked to pollution, are three times higher among African Americans.



Figure 10. Asthma Rates for Children in NYC.

# Displaced Communities and People Experiencing Homelessness

According to the <u>Bowery Mission</u>, nearly one in every 125 New Yorkers is homeless. In December 2019, there were 62,590 homeless people, including 14,792 homeless families with 22,013 homeless children, sleeping each night in the New York City municipal shelter system. Families make up more than two-thirds of the homeless shelter population. (<u>Coalition</u> for the Homeless). Research shows that the lack of affordable housing is a driving factor, with a large majority of vulnerable populations experiencing homeless also dealing with mental and physical health issues. Approximately 57 percent of heads of household in shelters are African-American, 32 percent are Latinx, 7 percent are white, less than 1 percent are Asian-American or Native American, and 3 percent are of unknown race/ethnicity.

## **Health Workers and Frontline Responders**

According to the <u>Center for Health Workforce Studies</u>, in 2014, there were nearly 20 million jobs in the US either in the health sector or in health occupations employed outside the health sector, accounting for over 13% of the total US workforce. In <u>New York State</u>, there were 1.2 million in the healthcare field, (13.5 percent of total employment), with 516,736 health care professionals in New York City. As of 2016, the NYC Fire Department reported 4,500 Emergency Medical Services workers.

## **Incarcerated Individuals**

According to the NYC Comptroller and <u>NYC Department of</u> <u>Corrections</u>, there are currently 8,136 inmates in the city's limits. In New York State, there are over 92,000 people in a federal, state or local prison. People of color are overrepresented with 53.3% African American, 33.9% Hispanic, 7.5% White, 3.7% Other and 1.6% Asian. The average age is 35.6, and women represent 6% of the total population.

According to <u>City Limits</u>, there are 14 prisons located throughout New York City. The Bronx is home to two current facilities, while Manhattan has five; Brooklyn has four and Queens has three. There are none in Staten Island. In recent reports from the Legal Aid Society (via <u>Gothamist</u>) COVID-19 has been reportedly spreading on Rikers Island. 900 incarcerated people on Rikers are over 50-years-old. About 600 have chronic medical conditions, 300 are held on a parole warrant, 200 are held on bail, and about 75 are serving a city sentence—or less than one year.

#### **Research Highlight**

How will COVID-19 and potential weather extremes interact to drive social, economic, and health impacts for vulnerable populations in New York City?

As the coronavirus continues to expand in cities like New York, fundamental questions about who will be most impacted are critical to understand for improving local and state level COVID-19 emergency responses, and resilience policy and planning. The USL is examining how potential impacts of shifting human behavior and shelter-in-place policies will interact with changing weather and potential weather-related extremes such as heat waves, flooding, or storm events that could damage critical infrastructure for COVID-19 responses. This is especially critical as current models (Ferguson et al. 2020) predict COVID-19 cases and deaths may not peak until June 2020 or later with social distancing policies in place that could last through summer 2020. These policies may shift exposure for already at-risk communities to climate and weather-related extremes and further affect demand for energy, internet access, air conditioning, food, health and other critical services.

The USL team is working to integrate social media, building infrastructure, energy demand and use, mobility and socialdemographic data that leverages cutting-edge simulations, modeling, and visualizations of urban social and infrastructure systems to create novel insights into interdependent COVID-19 vulnerability and social vulnerability to extreme weather. Scroll down below to see our initial social vulnerability analysis and mapping, and stay tuned for further updates.

The USL Data Visualization Platform is an interactive web application that provides 3D visualizations of socio-ecological data meant to aid city planners, first responders, researchers, NGOs, and local community groups in envisioning strategies for creating more just and resilient urban futures.

To explore NYC data including interactive exploration of vulnerability indicators in 3D, please see the USL Data Visualization Platform. The platform was developed in part to begin understanding these COVID-19 related intersecting conditions, and to envision strategies for creating more just and resilient urban futures. We are currently working to update our map layers to provide a helpful understanding of where the most vulnerable communities are located and why. To explore and share the map visit: <u>http://nyc.urbansystemslab.com/</u>



**Figure 11**. Elderly Population over 65: 2010 Census Blocks. Recent analysis has shown that elderly people are more at risk of the effects of Coronavirus. Elderly people, like other demographics, are not spatially uniform and so some areas of the city represent hotspots of potential risk. (Note: Will update with 2018 data shortly)

The USL is compiling a list of key research, datasets, and relevant articles that may be important to stay informed of during this ongoing crisis. Keep an eye on this space for updates, <u>send us resources to add</u>, and let us know what else you'd like to see here.

Depietri, Yaella, Khila Dahal, Timon McPhearson. 2018. "Multihazard risk in a coastal megacity." *Natural Hazards and Earth Systems Sciences* 18:3363-3381, https://doi.org/10.5194

#### /nhess-18-3363-2018 (PDF)

Ortiz, Luis E., Jorge E. González, Radley Horton, Wuyin Lin, Wei Wu, Prathap Ramamurthy, Mark Arend, Robert D. Bornstein. 2019. "High-Resolution Projections of Extreme Heat in New York City." *International Journal of Climatology*, https://doi.org/10.1002/joc.6102 (PDF)

Andersson, Erik, Johannes Langemeyer, Sara Borgström, Timon McPhearson, Dagmar Haase, Jakub Kronenberg, David N. Barton, McKenna Davis, Sandra Naumann, Lina Röschel, Francesc Baró. 2019. "Enabling Urban Green and Blue Infrastructure to Improve Contributions to Human Wellbeing and Equity in Urban Systems." *BioScience*, https://doi.org/10.1093/biosci/biz058 (PDF)

McPhearson, Timon, & Jones, N. The Liveable City. *Our Future on Earth 2020*. Future Earth. (PDF)

Andersson, Erik, Sara Borgström, Timon McPhearson. 2017. "Double insurance in dealing with extremes – Ecological and social factors for making nature based solutions last," in *Nature-based Solutions to Climate Change in Urban Areas* (Nadja Kabisch et al., eds), Springer (<u>PDF</u>)

McHale, Melissa R., Steward TA Pickett, Olga Barbosa, David N Bunn, Mary L Cadenasso, Daniel L Childers, Meredith Gartin, George Hess, David M Iwaniec, Timon McPhearson,
M. Nils Peterson, Alexandria K. Poole, Louie Rivers III, Shade T Shutters, Weiqi Zhou. 2015. "The New Global Urban Realm: Complex, Connected, Diffuse, and Diverse Social-Ecological Systems." *Sustainability (Special Issue)*, 2015, 7, 5211-5240. doi:10.3390/su7055211 (PDF)

McPhearson, Timon. 2013. "Wicked Problems, Socialecological Systems, and the Utility of Systems Thinking." *The Nature of Cities*, <u>http://www.thenatureofcities.com/?p=2180</u>

Depietri, Yaella, Timon McPhearson. "Changing urban risk: 140 years of climatic hazards in New York City." *Climatic Change* 148:95-108, https://doi.org/10.1007 /s10584-018-2194-2 (PDF).

Depietri, Yaella, Timon McPhearson. "Integrating the grey, green, and blue in cities: Nature-based solutions for climate change adaptation and risk reduction," in *Nature-based Solutions to Climate Change in Urban Areas* (Nadja Kabisch et al., eds), Springer (PDF)

Jared Anderson, Kassia Micek, and Jeff Ryser. (2020). COVID-19-related load impacts are being reported by several US grid operators. S&P Global Platts. Retrieved from https://www.spglobal.com/platts/en/market-insights/latestnews/electric-power/032320-covid-19-related-load-impactsare-being-reported-by-several-us-grid-operators

Christina Goldbaum and Lindsey Rogers Cook. (2020). They Can't Afford to Quarantine. So They Brave the Subway. NY Times. Retrieved from <u>https://www.nytimes.com/2020/03</u> /30/nyregion/coronavirus-mta-subway-riders.html

Caroline Spivack. (2020). Here's how the coronavirus pandemic is affecting public transit. Curbed. Retrieved from <u>https://ny.curbed.com/2020/3/24/21192454/coronavirus-</u>

nyc-transportation-subway-citi-bike-covid-19

NYC Department of Planning. (2020). "New York City Population." Retrieved from <u>https://www1.nyc.gov</u> /site/planning/planning-level/nyc-population/populationfacts.page

US Census Bureau. (2018). American Community Survey (ACS). Retrieved from https://www.census.gov/programs-surveys/acs

Centers for Disease Control. (2020> Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020. Retrieved March 18, 2020. <u>https://www.cdc.gov/mmwr/volumes/69/wr</u> /mm6912e2.htm?s\_cid=mm6912e2\_w

Naidoo M, Traore K, Culp G, King L, Lopez C, Hinterland K, Gould LH, Gwynn RC. (2018). Community Health Profiles 2018 Map Atlas. The New York City Department of Health and Mental Hygiene. Retrieved from <u>https://www1.nyc.gov/assets</u> /doh/downloads/pdf/data/2018-chp-atlas.pdf

Irfan, U. and Belluz, J. (2020). Vox. "Why Covid-19 is so dangerous for older adults." Retrieved from <u>https://www.vox.com/2020/3/12/21173783/coronavirus-death-</u> age-covid-19-elderly-seniors

Elias, Melinda. (2018). "Are NYC Health + Hospitals Facilities Located in Community Districts With the Highest Shares of Uninsured New Yorkers?" New York City Independent Budget Office. Retrieved from <u>https://ibo.nyc.ny.us/iboreports/h+h-</u>

#### facilities-uninsured.pdf

American Academy of Allergy Asthma & Immunology. (2020). "Asthma Statistics." Retrieved from <u>https://www.aaaai.org</u> /about-aaaai/newsroom/asthma-statistics

New York City Department of Health and Mental Hygiene. (2018). New York City Community Health Profiles. Retrieved from <u>https://www1.nyc.gov/site/doh/data/data-publications</u> /profiles.page

Calma, Justine. (2020). Air pollution could make the COVID-19 pandemic worse for some people." The Verge. Retrieved from <u>https://www.theverge.com/2020/3/19/21186653</u> /coronavirus-covid-19-air-pollution-vulnerable-lung-diseasepandemic

Lerner, Sharon. (2020). "2.2 Million People in the US Could Die if Coronovirus Goes Unchecked." The Intercept. Retrieved from <u>https://theintercept.com/2020/03/17/coronavirus-air-</u> <u>pollution/</u>

Bowery Mission. (2020). "Homelessness is a Shared Experience in the New York Metro Area." Retrieved from https://www.bowery.org/homelessness/

Coalition for the Homeless. (2020). Basic Facts About Homelessness: New York City. Retrieved from https://www.coalitionforthehomeless.org/basic-facts-abouthomelessness-new-york-city/

Center for Health Workforce Studies, State University of New York. (2018). The Health Care Workforce in New York: Trends

in the Supply of and Demand for Health Workers. Retrieved from <u>http://nyachnyc.org/wp-content/uploads/2018/04/CHWS-</u> The-HC-Workforce-in-NY-2018.pdf

New York State Comptroller. (2018). Vital Signs: Health Care Employment Gains Across New York State.

https://osc.state.ny.us/reports/economic/health-careemployment-2018.pdf

NYS Department of Corrections. (2019). Information for 1st 6 months FY 2019. <u>https://www1.nyc.gov/assets/doc/downloads</u> /press-release/DOC At%20a%20Glance-1st6 Months FY2019 012919.pdf

DiPrinzio, H. (2018). The Jail Next Door: A Look at the 14 Correctional Facilities in New York's Neighborhoods City Limits. Retrieved from <u>https://citylimits.org/2018/07/17/the-jail-next-door-a-look-at-the-14-correctional-facilities-in-new-yorks-neighborhoods/</u>

Pereira, S. (2020). "Inmate And Correction Officer On Rikers Island Tests Positive For Coronavirus As Calls To Release Inmates Intensify" Retrieved from <u>https://gothamist.com</u> /news/correction-officer-rikers-island-tests-positivecoronavirus-calls-release-inmates-intensify

Mayor's Office for Economic Opportunity. (2019). New York City Government Poverty Measure 2017: An Annual Report from the Office of the Mayor. Retrieved from <u>https://www1.nyc.gov/assets/opportunity</u> /pdf/19\_poverty\_measure\_report.pdf Spivack, C. (2020). Curbed. "New York lawmakers move to ban evictions during the coronavirus outbreak." Retrieved from <u>https://ny.curbed.com/2020/3/12/21177133/nyc-tenant-</u> eviction-moratorium-coronavirus

Ortiz, Luis E., Jorge E. González, Radley Horton, Wuyin Lin, Wei Wu, Prathap Ramamurthy, Mark Arend, Robert D. Bornstein. 2019. "High-Resolution Projections of Extreme Heat in New York City." International Journal of Climatology, https://doi.org/10.1002/joc.6102

New York City Panel on Climate Change. (2019). New York City Panel on Climate Change 2019 Report Chapter 6: Community-Based Assessments of Adaptation and Equity. Retrieved from <u>https://nyaspubs.onlinelibrary.wiley.com</u> /doi/10.1111/nyas.14009

Sonal J., Sawyer S., and Hernández, D. (2019). Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature. Frontiers in Public Health. <u>https://doi.org/10.3389/fpubh.2019.00357</u>

Dominianni C, Lane K, Johnson S, Ito K, Matte T. Health impacts of citywide and localized power outages in New York City. Environ Health Perspect. (2018) 126:067003-1–12. 10.1289/EHP2154

Zbigniew Grabowski, Pablo Herreros, Rositsa T. Ilieva, Chris Kennedy, Ahmed Mustafa, Timon McPhearson, Luis Ortiz, Claudia Tomateo, Daniel Sauter, Joseph Steele, and others on the USL Team.





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