Sustainable Revival in NYC

Transforming the Concrete Jungle

A Decade of Progress in Air Quality, Green Spaces, Clean Energy and Bike Sharing in New York City.

Group Mini Project: Digital Visualisation Report

CASA0003 2022-2023

Group 02

List of Assignments

Project Output	**Output Description**
Project Output Files	Zip File on Moodle (Including report, presentation slides & code)
Project Website	https://digivisual-2023-group02.github.io/CASA0003/Home.html
Github	https://github.com/DigiVisual-2023-Group02/CASA0003
Data Source	In the appendix of the report

Table of Content Word Count: 5710

1. Introduction **4**

1.1 Project Overview 4

1.2 Research Questions 5

1.3 Motivation 6

1.3.1 Air Quality 6

1.3.2 Green Spaces 7

1.3.3 Clean Energy 8

1.3.4 Bike Sharing 9

2. Process **11**

2.1 “About” Page 11

2.2 Air Quality 11

2.3 Green Spaces 12

2.4 Clean Energy 15

2.5 Bike Sharing 18

3. Technical Challenges **20**

3.1 Air Quality 20

3.2 Green Spaces 22

3.2.1 Technical Challenges and Solutions: 22

3.2.2 Techniques Used: 23

3.3 Clean Energy 24

3.3.1 Challenges 24

3.3.2 Techniques used 25

3.4 Bike sharing 25

3.4.1 Challenges 25

3.3.2 Techniques used 25

4. Summary **26**

References **27**

Appendix **30**

Contribution Table 30

Contribution List 31

Data Sources 33

1. Introduction

1.1 Project Overview

Since the laid out of "OneNYC" strategy in 2015, the city has been facing the challenges of climate change on multiple aspects such as **making the New York City "the most sustainable big city in the world"** (DCP, n.d.) and has been committed to ensuring a sustainable future with urban regenerations (OneNYC, 2015d). As urban renewal offers valuable opportunities for sustainability, the former one is the key to sustainable development and is the process of reusing resources and rebuilding the urban environment (Zheng et al., 2017). The strategy has driven a series of initiatives in sustainability, including increasing green spaces, promoting the adoption of clean energy vehicles, and encouraging the use of public transportation and bicycles for commuting. Considering this, the aim of our project is to explore how this strategy can contribute to improving air quality in New York City.

It says in the strategy report that the goal for improving the air quality is to ensure that the city "will have **the best air quality among all large cities in the U.S. by 2030**" (OneNYC, 2015d, p. 188). The air quality in New York City is closely related to the presence of air pollution and combustion emissions (Matte et al., 2013), with one of the major contributions being vehicle exhaust. In addition to urban regeneration proposals based on sustainable development criteria and greenhouse gas reduction strategies, "cities must also take long-term measures to adapt to climate change" (Sánchez et al., 2018). Urban green space planning will be included as one of the possible impacts of climate change.

Considering this, our research aim is to see if New York City is moving towards a sustainable future from the past decade to the present (from 2011 to 2021) and if the *OneNYC* strategy issuance is accelerating this trend. The project will explore the connections between air quality with the expansion of green spaces (King et al., 2014), the promotion of clean energy vehicles, and the implementation of bike-sharing programs, **where green spaces enhance the air quality and clean energy vehicles and bicycles are both designed to reduce vehicle emission pollution.**

1.2 Research Questions

We therefore expanded our research questions as follows:

RQ1: Has New York's air quality improved over this decade? and has the 2015 strategy accelerated the improvement?

RQ2: Is there a relationship between the improvement in air quality and the increase in green space, clean energy, and the promotion of cycling?

Based on these questions, we therefore designed our topic as “**Sustainable Revival in NYC: Transforming the Concrete Jungle**”. Through analysis and visual representations, we aim to show the following four aspects:

1. Air Quality Improvement Trends: First we will present trends in the improvement of air quality in New York City over the past decade by analysing air quality indicators. This includes examining parameters such as particulate matter concentration (PM2.5), and emissions of pollutants (NO^2, NO, etc.).
2. Expansion of Green Spaces: The first of the three contributors to air quality is the green space. We will highlight the increase in greenery within the city and explore their impact on air quality. Through visualisations such as maps and charts, we will show the changes in green coverage and its relationship with air quality.
3. Promotion of Clean Energy: In this part, we will delve into the growth of clean energy adoption in New York City, including the expansion of renewable sources and the implementation of sustainable practices. This will involve examining the contribution of clean energy to reducing combustion emissions and its positive effects on employment.
4. Bike Sharing Systems: In this last section we will analyse the usage trends of bike-sharing programs in the city and explore their potential impact on air quality. This will include examining the development of bike infrastructure and stations and its user flows divided into different boroughs.

1.3 Motivation

Based on the above description, we present this part also in four sections, mainly to inspire our policies and literature.

1.3.1 Air Quality

In NYC2050, Healthy lives is an important part of City Revival and good air quality is one of the key factors for people's health and well-being (OneNYC, 2015a). As densely populated areas, cities are exposed to many sources of air pollution, such as traffic emissions, industrial emissions and building emissions. Therefore, paying attention to and improving air quality is crucial to urban regeneration.

Firstly, concern for air quality is directly related to the health of residents. Air pollutants, particularly fine particulate matter (PM2.5) and ozone (O3), have been shown to be associated with many health problems. Long-term exposure to polluted air can lead to respiratory diseases, cardiovascular diseases, lung cancer and other health problems (NYC Gov, n.d.). By taking measures to reduce sources of pollution and improve air quality during urban regeneration, the risk of disease for residents can be reduced and their quality of life and health can be improved.

Secondly, improving air quality is closely linked to the quality of life of residents. Good air quality is not only good for health, but also has a positive impact on people's feelings of life and well-being. Clean air provides a pleasant environment, improves the living experience and promotes the psychological well-being of residents (Silva et.al., 2012; Shi et al., 2021).

In addition, concern for air quality is an important aspect of sustainable development. Urban regeneration is not just about focusing on current urban issues, but also about thinking and planning with a long-term perspective. Good air quality is the basis for achieving sustainable development goals. By reducing pollutant emissions and promoting measures such as clean energy and sustainable transport, urban regeneration can reduce environmental pollution, improve ecosystems, conserve natural resources and create a healthier and more sustainable urban environment for future generations (NYC Nature Goals 2050, n.d.).

In addition, improving air quality is closely linked to social equity in cities. Air pollution tends to have a greater impact on socio-economically disadvantaged groups, exacerbating social inequalities. Poorer communities and marginalised areas often bear higher levels of pollutant exposure, which leads to inequitable health disparities. Special attention should be paid to air quality in these communities during urban regeneration to reduce socio-economic disparities and achieve social equity by improving environmental quality and providing equitable health conditions (OneNYC, 2015b).

Finally, good air quality also has a positive impact on the economic development and competitiveness of cities. A clean air environment helps to attract investment, promote industrial development and create jobs (OneNYC, 2015c). Cities with good air quality are more attractive, attracting more visitors and residents and contributing to their economic growth and sustainable development.

In summary, attention to air quality is an important driver in urban regeneration. By improving air quality, we can improve the health status and quality of life of residents, promote sustainable development, achieve social equity, and enhance the economic development and competitiveness of cities. In the process of urban regeneration, policy makers, researchers and community residents should work closely together and adopt effective measures and strategies to work together to improve air quality and create a healthier, liveable and sustainable urban environment.

1.3.2 Green Spaces

An increased emphasis on the expansion of green spaces plays a pivotal role in urban revitalization. Green spaces, which encompass parks, gardens, and tree-lined streets, serve as crucial players in enhancing the quality of air within urban environments. Acting as natural filters, the vegetation within these spaces mitigates air pollution levels, thereby enhancing overall air quality.

An examination of policies implemented in New York City unveils an array of initiatives advocating for the augmentation of green spaces within the urban matrix. Among these is the MillionTreesNYC initiative, inaugurated in 2007, which envisioned planting and nurturing one million trees across the city (New York City Department of Parks & Recreation, n.d., 2007). This quintessential instance of urban greening within New York City has the potential to profoundly impact all city-dwellers as parks and streets evolve into ecologically vibrant forests. It has resulted not only in an increased tree canopy but also in the creation of novel green spaces such as tree-lined streets and parks, which contribute substantially to improving air quality.

New York City's urban forest, encompassing approximately seven million trees scattered throughout city streets, parks, backyards, and woodland areas, significantly enhances air quality, resilience, health, and environmental quality. This vast verdant network, which accounts for 22% of the city's total area, is instrumental in mitigating air pollution, sequestering carbon, managing stormwater, and reducing energy consumption in buildings (New York City Mayor's Office, 2019).

Green spaces function as an air filtration system, capturing and absorbing harmful substances to enhance the overall air quality (Kuo & Sullivan, 2001). Moreover, these green spaces aid in alleviating the urban heat island phenomenon and diminishing energy usage, thus promoting a healthier and more sustainable urban habitat (Astell-Burt et al., 2014). The interconnection between urban policies, greening initiatives, and improved air quality paints a promising future for sustainable urban development. An ongoing commitment to expanding green spaces will undoubtedly act as a catalyst for a healthier and more sustainable city, thereby providing a blueprint for other urban centres globally..

In pursuit of our research objectives, we underscore the importance of expanding green areas within the city of New York. Leveraging visualisation tools such as graphs and maps, we aim to depict the evolution of green coverage over time. This critical analysis of changes will enable us to draw a correlation between the proliferation of green spaces and the subsequent improvement of air quality.

1.3.3 Clean Energy

Over the last decades, there has been a growing interest in the use of renewable energy at the urban level. One factor is the growing attention to the larger concern of urban sustainability. One of the most important goals for many countries is to achieve sustainable urban development (Hassan & Lee, 2015). And the development of **urban renewal energy policies** also deserves our attention, as cities are an important part of the global energy equation (Hammer, 2008). While the range of energy initiatives undertaken by New York City was quite comprehensive, according to Hammer (2008), there has not been a coherent strategy to guide the way for New York historically. That is, until the advent of the predecessor of *OneNYC*, ***plaNYC2030***, which set out a series of long-term, sustainable plans for the future of the city.

Since 2008, the concept of a **green economy and 'green growth'** emerged (Ferguson, 2015). Birney and McNamara (2021) refer to green jobs based on these, a concept developed by the Bureau of Labor Statistics in 2012, which helps to reduce energy consumption. Wei et al. (2010) show that many studies have found that the increased use of renewable energy can create many jobs, leading to economic benefits that are not overly dependent on limited energy sources. New York is also responding to the growth of the green economy by offering a number of **clean energy related jobs**. The New York State Clean Energy Industry Report (NYSERDA, 2022) cites a much higher number of clean energy business-related jobs in 2021 than in 2015, with a 17% growth rate.

In the paper by Pitiranggon et al. (2021), it is mentioned that early studies have shown that previous **transportation pollution** can account for half of New York's total $PM^{2.5}$. Meanwhile, Lovasi et al. (2022) mentioned in their paper that motor vehicles including buses are one of the main sources of air quality pollution in New York City. Air pollutants such as SO^2 and NO^2 are the main components of vehicle exhaust. The use of public transportation can **reduce emissions from private vehicles**, but air pollution from traffic is still not to be taken lightly. Promoting the use of clean energy and reducing pollutant emissions will only help to improve air quality. In addition to the promotion of bicycle sharing, the promotion of clean energy vehicles is also linked to the economy.

In recent years, transportation has been an outstanding record for NYC when it comes to energy and the environment. Several local and federal regulations have been introduced to reduce traffic emissions, and they have been effective. Not only that, but the city is also a global leader in the field of **alternative fuel vehicles** (Hammer, 2008). It is also targeting the fuel usage of private vehicles, encouraging taxis to switch to **clean energy sources** such as natural gas and hybrid electricity.

1.3.4 Bike Sharing

Public transportation usually plays a very important role in urban green development, and in the last ten years, shared bicycles have developed rapidly and made many contributions to the sustainable development of cities. The increased energy expenditure required by walking, cycling and public transit contributes to low rates of obesity and mental health (Basset 2008). In New York City, which has a very high population density, the popularity of bike-sharing not only has a positive impact on people's mental and physical health, but also makes the city greener and cleaner. So, focusing on the development and promotion of bike-sharing is an important manifestation of urban regeneration at a green and sustainable level.

When people are more inclined to use bike-sharing to travel, the use of cars will gradually decrease, which will lead to lower exhaust emissions from cars, thus reducing air pollution and greenhouse gas emissions, making the air cleaner and helping to protect the environment and mitigate climate change. For cities, bike-sharing, as the most convenient means of transportation for short-distance travel, can be a good way to improve traffic congestion in cities, reduce the pressure on road traffic, and make cities more orderly.

In addition, bicycle sharing has a positive impact on the physical and mental health of residents. Cycling is a healthful form of physical exercise. Promoting bike-sharing can encourage people to increase their daily physical activity, improve their physical health, and enhance their quality of life. In addition, bike-sharing can make it easier for people to travel and move around the city, increasing the flexibility and convenience of travel.

In terms of economy, bike sharing also has a great contribution. First, bike sharing can save costs. Compared to private bicycles, bike sharing does not require additional costs such as purchase, maintenance, and parking. Bike sharing is an affordable option for those who don't ride bicycles often or don't have one temporarily. At the same time, bike-sharing can reduce the economic burden of transportation by reducing the reliance on cars and motorcycles, as well as reducing the demand for non-renewable resources such as gasoline and oil. In addition, the site construction and maintenance costs of shared bikes are much lower than the construction costs of public facilities such as buses and subways, which can save social spending to a certain extent. Its site construction and maintenance can also provide more green economic jobs, allowing for better development of a green society.

In summary, the promotion of bike-sharing can help solve environmental, transportation, health, and economic problems. It is not only a mode of transportation, but also a symbol of a sustainable lifestyle. By promoting bike-sharing, more people can be encouraged to choose an environmentally friendly and healthy way to travel, promoting sustainable social development and urban regeneration.

2. Process

The overall design of our website is link-hopping. By clicking on the navigation bar, users can jump to the corresponding page.

2.1 “About” Page

This page is a short introduction to our project, mentioning the source of the concept and a brief introduction to the subject of the subsequent pages. We have designed four icons after the text introduction to act as jump buttons for the four category pages, when the user clicks on the icons, they are redirected to the corresponding topic sub-page.

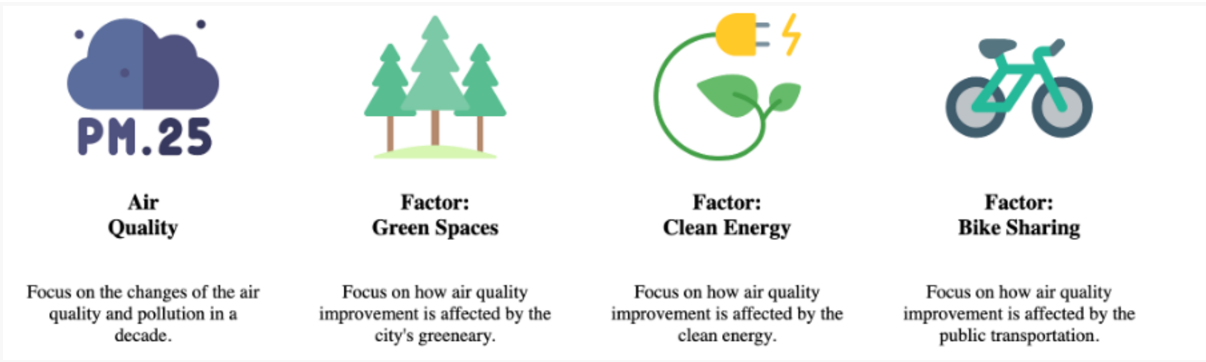

Figure 2.1.1 - Icons

2.2 Air Quality

Secondly, we selected a few representative trends in decreasing concentrations of key air pollutants from 2013 to the most recent data year to demonstrate the overall change in average air quality in NYC over recent years.

We then used an interactive Choropleth Map to show the air pollution levels for each community district in NYC, with a year slider from 2013 to 2021 in the top left window, and some buttons to toggle air pollutants. These two interactive modules allow users to easily observe the concentration of individual air pollutants in different community districts and the change in air quality over time. To make it easier for users to search for detailed data, we have added a pop-up window on the large map to show raw data for a community district over time, to fill in the subtle changes that cannot be observed from a simple visual comparison of colour changes.

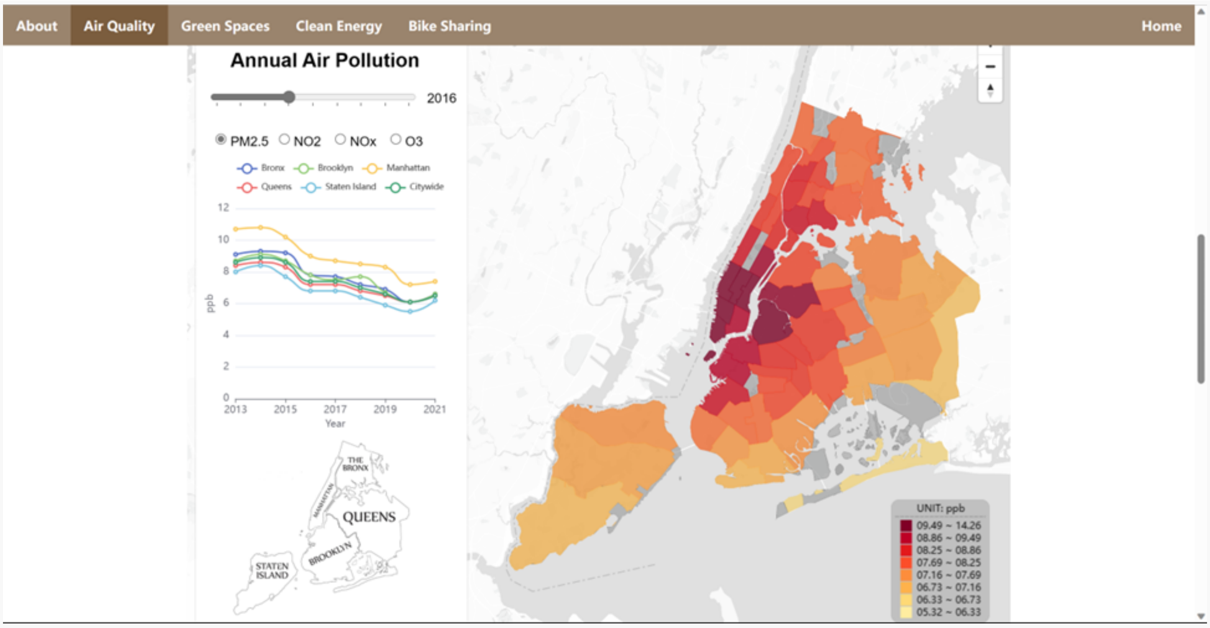

Figure 2.2.1 - Choropleth Map

In addition, we have added a line graph of the different boroughs and citywide that can be switched by the pollutants button above, along with a map of the NYC boroughs for those who do not know NYC's geographic location very well, so that users can see the changes in air quality data at different geographic levels at the same time.

As the colour of the map changes, we can see that the air quality in NYC has been gradually improving over the years, with greenery, air purification and traffic reduction contributing to this, and then some relevant data and line graphs are shown to link the air quality and subsequent page topics.

Finally, there is the uniform format of reference and copyright.

2.3 Green Spaces

Data Collection: The first step in this process was collecting and understanding the data. The source of our data was NYC OpenData, a repository of public datasets provided by the City of New York. From this source, we extracted information about the green parks of New York City, specifically focusing on their total area from the years 2000 to 2024.

Data Processing and Analysis: During data processing and analysis, we distilled the raw CSV files to extract relevant columns of information. These data were then converted into a more suitable format, GeoJSON, a standard in spatial data visualisation. This transformation allowed us to associate the park data with geographic attributes, which laid the groundwork for the subsequent interactive map visualisation. This step was key to ensuring the data was both accurate and optimised for our design needs.
Visualisation Design: Next, we designed a statistical chart to visually represent the total area of NYC's green parks from 2000 to 2024.

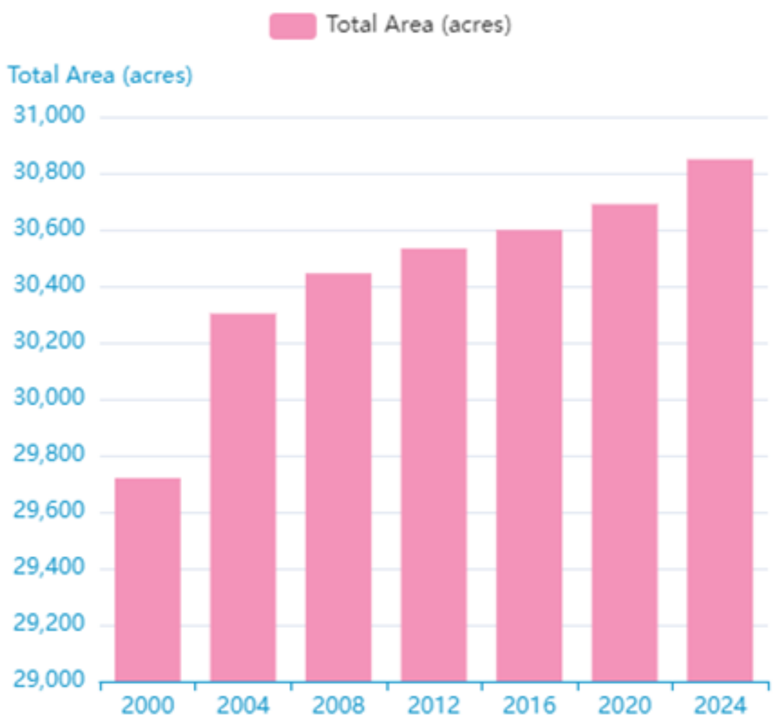

Figure 2.3.1 - Green Park Area Growth histogram

Interactive Map: Additionally, an interactive map was designed to further illustrate the expansion of green spaces in New York City. Different coloured blocks were used to signify the growth of green spaces every four years. This allowed for a visual understanding of the temporal growth of these parks.

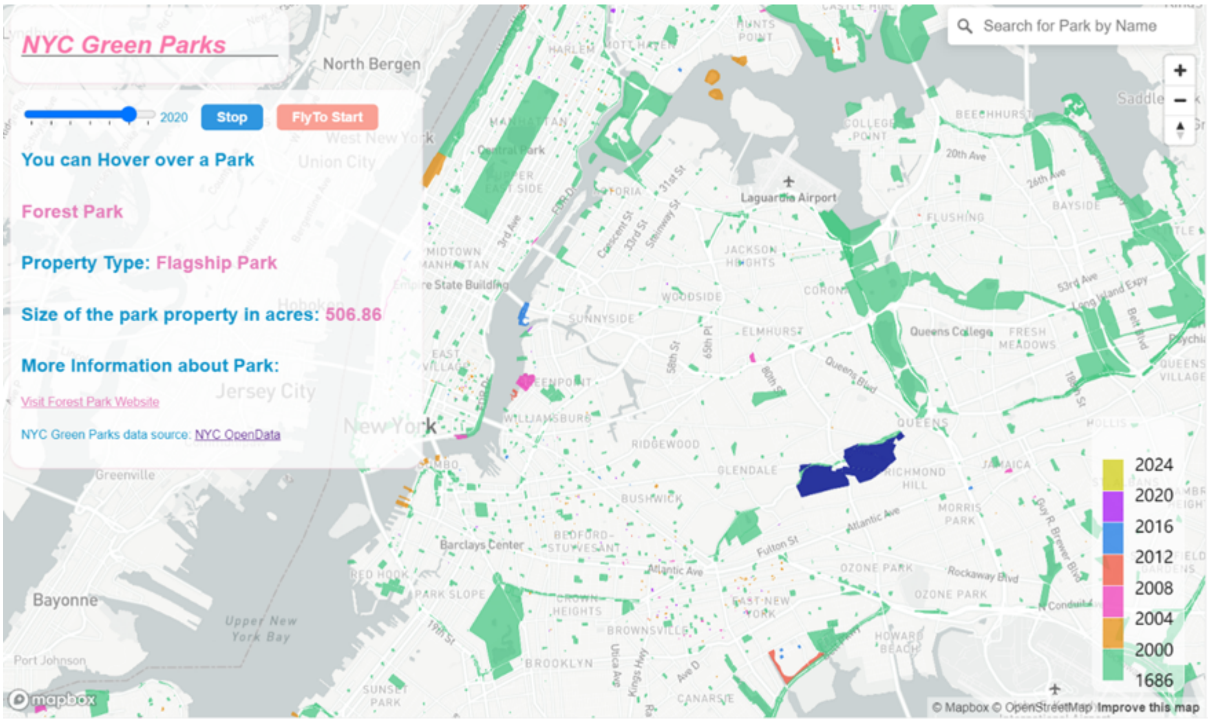

Figure 2.3.2 - Interactive Map

Animations and Interactivity: To enhance user engagement and provide a more dynamic experience, two animations were incorporated. The first was a timeline animation control that allowed users to observe how parks have expanded and changed throughout the years. The second was the ‘FlyTo’ feature, which enables users to zoom in and explore the parks added in each period in detail.

Figure 2.3.3 - Animation controls

Figure 2.3.4 - 'FlyTo' feature detail

Information Display: To provide additional information about each park, an interactive feature was designed. This allows users to hover their cursor over a park on the map to see more detailed information about it.

Search Functionality: Lastly, a search functionality was incorporated to provide a convenient way for users to quickly locate specific parks by name on the map.

2.4 Clean Energy

Design Processing:
In this part of the website, we mainly talk about the clean energy promotion in the city, named "A Cleaner City". First, we have a short introduction to the topic. Starting with the broad topic of the green economy, it mentions a series of measures advocated by New York to reduce energy consumption and promote electric vehicles. To present the city's flourishing green economy and sustainability efforts, We visualise them with related data mainly in the form of graphs. The data are taken from New York Clean Energy Industry Report and NYC Gov Open Data.

The content of this section is divided into four main parts, The first three sections are visual forms of charts and the last one is a map:

a) Clean energy employment:

For this section, we were only able to obtain data starting from 2015. We believe this is due to the release of the OneNYC strategy, as New York only began focusing on green job data related to clean energy from 2015 onwards. Here, we utilised an interactive chart that combines bar graphs and line graphs. The bar graph represents the growth in clean energy employment, while the line graph depicts the growth rate relative to the base year of 2015. Users can hover their mouse to view the values and proportions for each year.

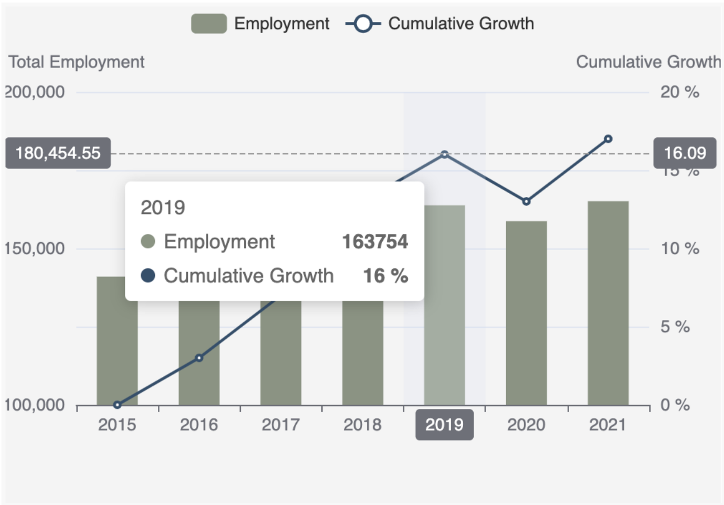

Figure 2.4.1 – The growth of clean energy employment in New York State from 2015 to 2021

b) Alternative transportation employment

Similar to the previous section, the data for this part covers the years 2016 to 2021. The presentation format is a bar graph, where different colours and proportions are assigned to various alternative transportation sources based on their numerical values.

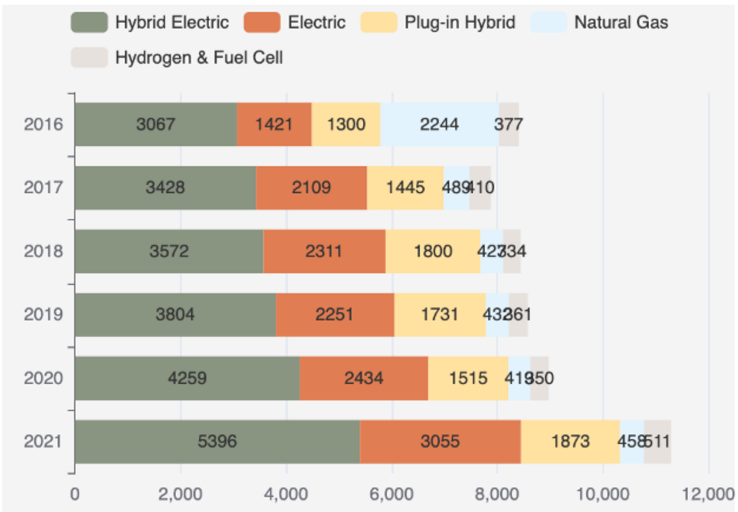

Figure 2.4.2 – The growth of employment in alternative transportation sector

c) Electric vehicle registrations

This section, along with the following one, displays data on electric vehicle (EV) registrations in New York City. We have employed a line graph to showcase the registration numbers, with two lines representing battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) separately.

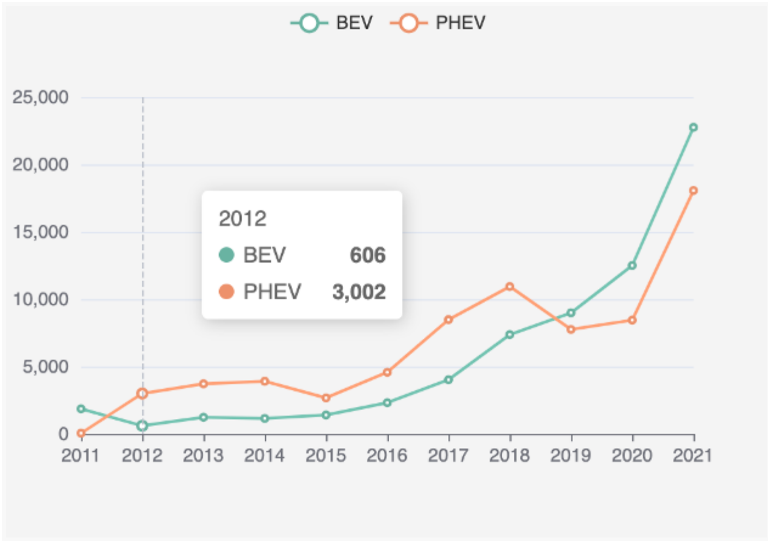

Figure 2.4.3 – The registrations of new electric vehicles in the state

d) Electric Vehicle Charging Station Locator

In this section, we have utilised a map to showcase the geographical locations of electric vehicle charging stations in New York City. Users can identify charging stations for different energy sources using different colours specified in the map legend.

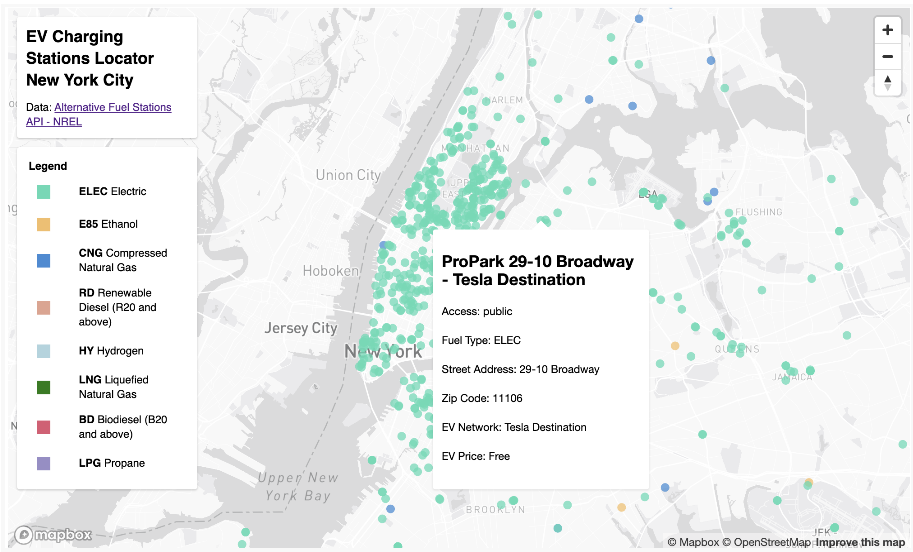

Figure 2.4.4 - Charging Station Locator

Data Processing:
Since the data for the charts is sourced from reports, we initially obtained the data from industry reports and converted it into CSV and JSON files for easier data handling. To generate interactive charts, we utilised the ‘ECharts’ library in our html files, which allows for seamless integration of data to create visually appealing and interactive charts.
The data for the map was sourced from the publicly available data provided by the city of New York, which encompasses charging station data from across the United States. To narrow down the dataset to New York City, we initially filtered out the relevant data. However, the dataset did not provide specific latitude and longitude coordinates for the charging stations. Instead, it offered zip codes as a reference. To enable accurate positioning on the map, we usePython to map the zip codes to approximate latitude and longitude coordinates, which were then imported into Mapbox to achieve accurate geolocation of the charging stations.

2.5 Bike Sharing

Data collection and processing: The first step in creating the visualisation is to collect the relevant data and process it into a usable format. The data for this section were taken from The New York City Department of Transportation's (NYC DOT), and we used Citi's bike-sharing data from 2014 to 2022. In the data processing part, the raw data is a csv file recorded once a month and stored in a separate folder, which needs to be integrated by different years and grouped and counted to extract the data needed to make charts and maps. For the charts, we mainly use the yearly count data and the count data of different districts, while for the maps, we need to additionally process the data into geojson format for mapbox to read and use.

Design processing: In designing the website, we focused on graphs and maps to show how the number of bike-sharing bikes has changed in various ways. First, we started with some of the benefits of bike-sharing and briefly described the impact of bike-sharing development on urban regeneration, focusing mainly on some of the air, health and economic impacts of bike-sharing. We then use linear to show the number of bike-sharing riders and the increase in bike-sharing stations per year. To make it easier for users to view the charts, we used Echart to create interactive charts and used interactive buttons to allow the charts to transform within a div, making the page more streamlined.

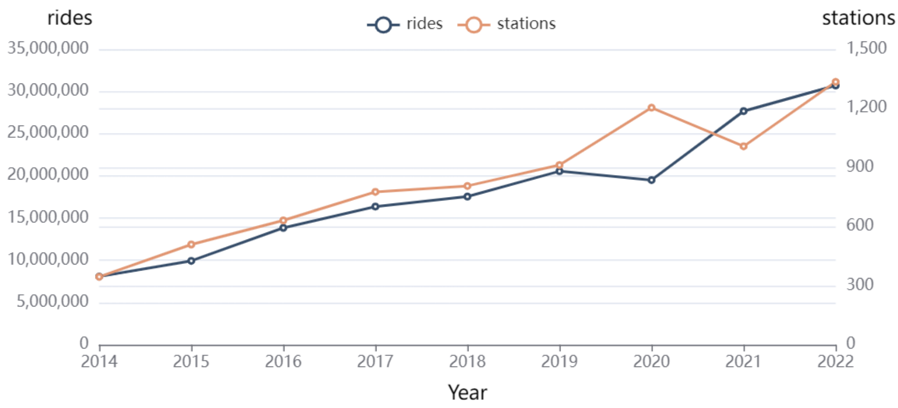

Figure 2.5.1 - Number of rides and stations

Then we focused on how the foot traffic changed at each site, so we used an interactive map to show that. On the map, circles are used to represent each of the different sites and shades of colour are used to indicate the amount of foot traffic at the site. Besides, we added a bar chart on the left of the page, to show the number of rides in different boroughs with the year.

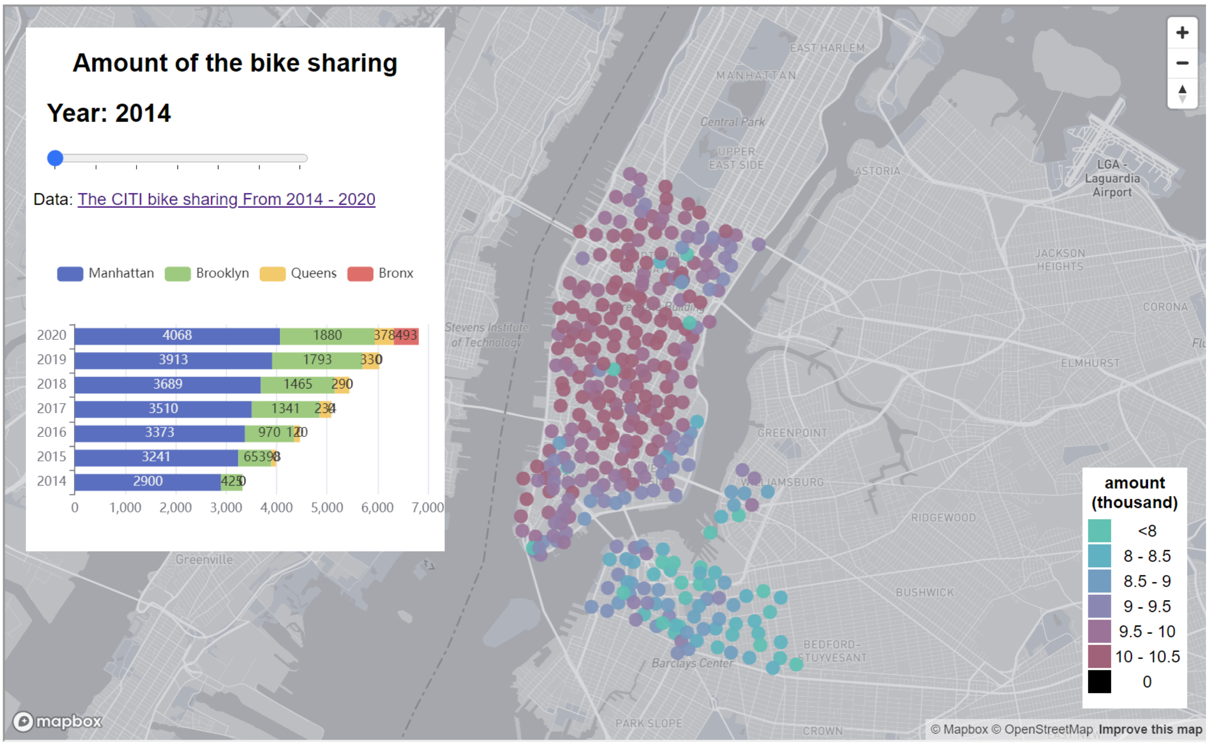

Figure 2.5.2 - Stations amount and location

3. Technical Challenges

3.1 Air Quality

During the creation of the Choropleth Map, it was a challenge to choose the right colour legend to accurately and efficiently represent the data, for which we tried a number of colour classification methods. Graduated Colours did paint all the values in different colours, but it was difficult to see the differences of colours between the areas at a glance.

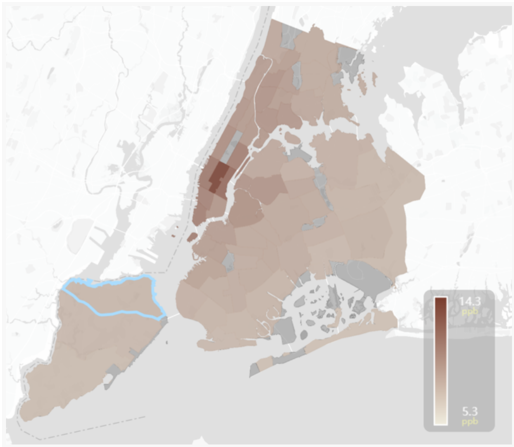

Figure 3.1.1 - Graduated Colours

Equal Interval classification would group most of the data in middle classes because the data are normally distributed.

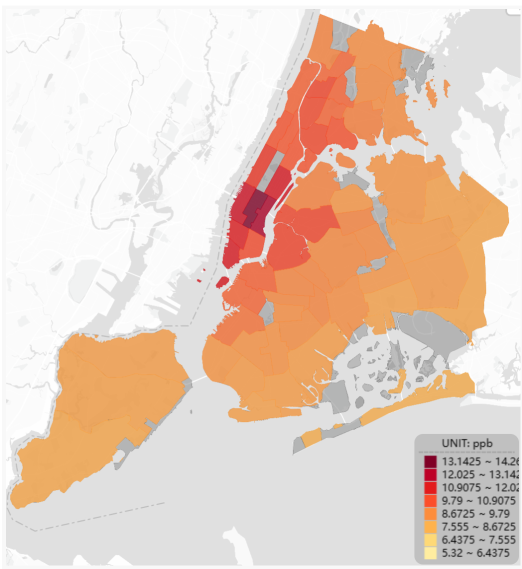

Figure 3.1.2 - Equal Interval

Geometric Interval classification can display the change of air pollution by the year slider really great, but lack of comparison in each year itself.

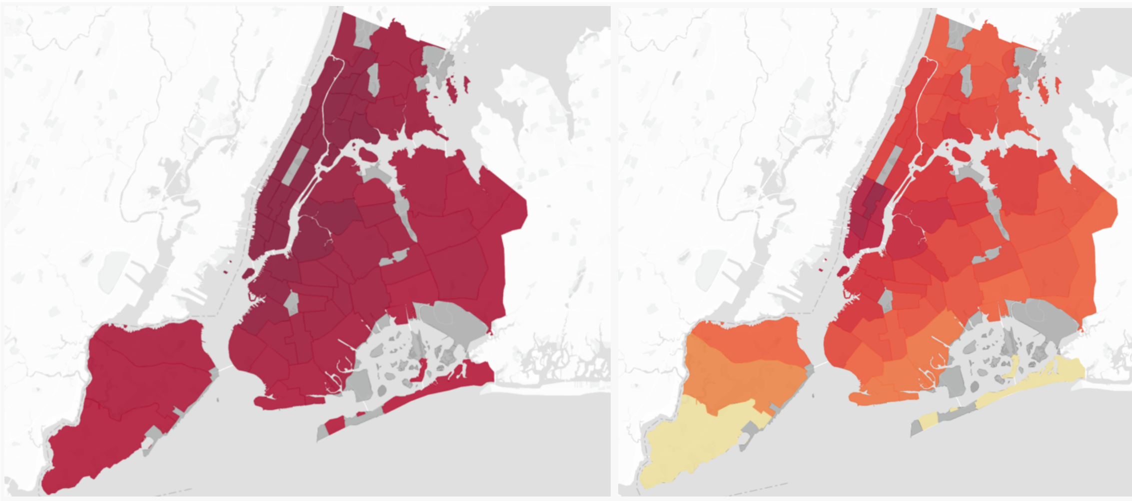

Figure 3.1.3 & 3.1.4 - Geometric Interval

We finally chose the Quantile classification to better show the comparative effect of air quality data, as it can display the change of air pollution by the year slider in a similar way to the Geometric Interval classification, while also providing a good contrast between community districts when looking at a single map.

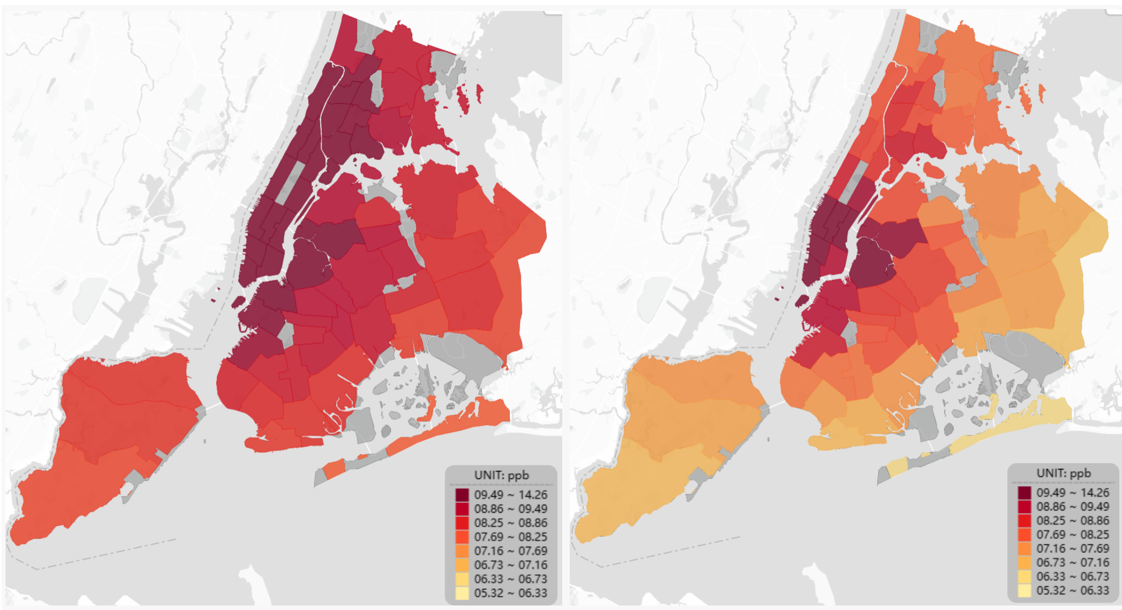

Figure 3.1.5 & 3.1.6 - Quantile

Secondly, to ensure that the page layout is not affected by browser or page scaling, we have fixed the width of the content to ensure a stable layout and to improve the adaptability of the page across different screens.

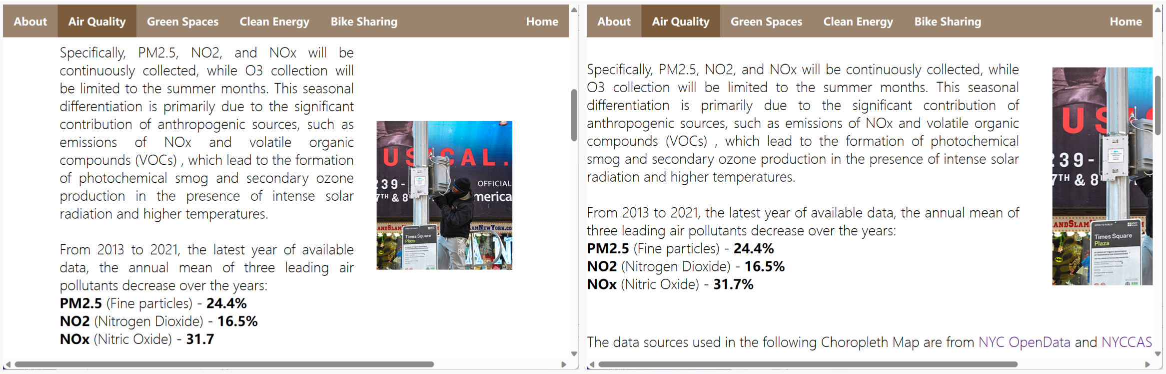

Figure 3.1.7 & 3.1.8 - Percentage VS Pixel

We also encountered a problem with the layout of the page, where the zooming function of the map conflicted with the scrolling function of the page. To resolve this issue, we made design adjustments to balance the scrolling and zooming functions by setting the width of the map and the layout of the page to provide a smoother user experience.

3.2 Green Spaces

3.2.1 Technical Challenges and Solutions:

a. Data integration: Integrating the park data into the visualisation map posed a significant challenge. The dataset contained information about park locations, attributes, and historical timelines. It was crucial to link this data with geographical coordinates and ensure accurate representation on the map.
Solution: To address this challenge, a GeoJSON format was utilised to store the park data. By carefully matching park attributes with their corresponding geographic coordinates, seamless integration into the map visualisation was achieved. Additionally, data preprocessing techniques were employed to clean and format the dataset, ensuring accurate and consistent information representation.

b. Dynamic timeline animation: Implementing a dynamic timeline animation that showcased the changes in park visibility over time required careful synchronisation between the timeline and the map visualisation.

Solution: JavaScript and HTML elements were employed to create an interactive timeline slider. This slider dynamically controlled the visibility of parks based on the selected year, offering users a seamless and engaging experience. By updating park visibility in real-time based on the slider's value, the desired timeline animation effect was achieved.

c. Interactive hover information: Providing informative hover information when interacting with parks on the map presented a challenge. The objective was to display relevant park details, such as names, property types, sizes, and additional information, in a visually appealing and user-friendly manner.
Solution: Map event listeners and HTML elements were leveraged to capture mouse hover events on the parks. Upon hovering, an information panel was dynamically populated with the corresponding park details. Styling techniques were employed to ensure clear and readable information display, enhancing the overall user experience.

3.2.2 Techniques Used:

Map Styling: This is achieved by using Mapbox GL JS, a JavaScript library for interactive, customizable vector maps on the web. The map style used is 'mapbox://styles/mapbox/light-v10'. The base map is light and monochromatic, providing a neutral background for the coloured park polygons.

Color-Coding: Different colours are assigned to the parks based on their establishment year. A 'step' expression is used in the 'fill-colour' property of the 'paint' object, which allows the map to use different colours for different year ranges. This provides a visual cue to understand the timeline of park establishment.

Dynamic Display with Hover and Slider: As mentioned above, the script implements dynamic display of park information with hover function and timeline visualisation with the slider. This interaction allows users to explore the data more deeply and intuitively.

FlyTo Animation: FlyTo animation is used to navigate through the parks in a certain order based on their establishment years. It gives the user a visual tour of the parks over the timeline.

Popup: Popup is used to display detailed information about the park detail at the animated view. It adds an additional layer of interactivity to the map.

GitHub Pages: We also use the GitHub Pages service, which allows others to view and interact with our site directly on the web.

3.3 Clean Energy

3.3.1 Challenges

Map visualisation: At first we wanted to present a 2.5D map of the distribution of charging stations and conducted the experiments shown below. The problem we encountered was that the 3D buildings that come with mapbox would disappear after the map had been scaled down to a certain zoom level.

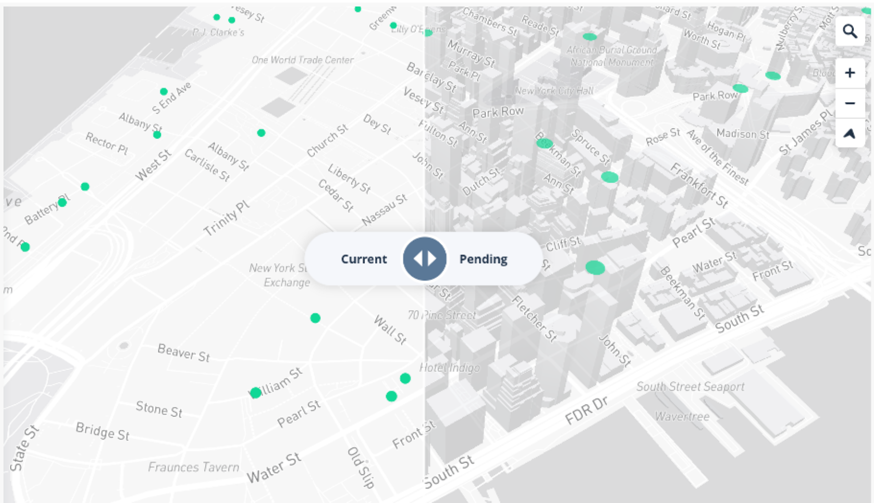

Figure 3.3.1 - Adjusting Map View

Solution: At first, we thought of importing the height data from NYC open data. However, the NYC building footprints file is nearly 1G in size and when using mapbox's tippecanoe plugin to convert it to .mbtile file, it goes up to zoom 9. If you try to increase the zoom level, you lose the data detail and the imported building footprints are not closed. Finally, for the sake of completeness and aesthetics of the map, we chose to show only the 2D distribution of charging stations, with interactions to show the geographical location of the data, fuel type, etc.

3.3.2 Techniques used

Charts with interactive information: we use echarts.js, import .csv data or read data directly to generate these charts.

Maps: we used Mapbox, read the api data information using d3.js and added popups to set the dynamic effects of mouse in/out.

3.4 Bike sharing

3.4.1 Challenges

Data manipulation: Manipulating a large dataset with not very well-defined records can be a tricky challenge. The original data is scattered in over a hundred folders and the fields differ between each csv, so it is difficult to integrate it into a complete dataset using file automation. Therefore, throughout the data processing, a series of python os operations are used to loop through the data each time, first understanding the format of the fields and the data needed for visualization, then using string matching to select which columns to extract for each file, and then grouping and counting them after composing a large raw table. It is also necessary to convert the csv file into a geojson file for mapbox drawing.

3.3.2 Techniques used

Charts with interactive information: we use echarts.js, import .csv data or read data directly to generate these charts.

Maps: we used Mapbox, read the data information using jquery.js and added popups to set the dynamic effects of mouse in/out.

4. Summary

This project is aimed at analysing the impact of the OneNYC strategy in making New York City a more sustainable metropolis. It particularly focuses on how this strategy has influenced the improvement of air quality from 2011 to 2021. Two primary research questions have been addressed:

> *RQ1: Has New York's air quality improved over this decade, and has the 2015 strategy accelerated the improvement?*
> *RQ2: Is there a relationship between the improvement in air quality and the increase in green space, clean energy, and the promotion of cycling?*

The project findings show that there has been a significant improvement in the air quality in New York over the past decade. Air quality indicators such as particulate matter concentration (PM2.5) and emissions of pollutants (NO2, NO, etc.) have seen a downward trend, showing the effectiveness of the OneNYC strategy. The strategy has indeed accelerated the improvement of air quality in the city.

Regarding the second question, the study found that there is indeed a correlation between the improvement in air quality and the increase in green spaces, clean energy adoption, and the promotion of cycling in the city. The expansion of green spaces has contributed to air purification, while the adoption of clean energy has led to a decrease in combustion emissions, a significant contributor to air pollution. The promotion of cycling has reduced vehicular emissions, thus improving air quality. The combination of these factors under the OneNYC strategy has evidently contributed to making New York City a more sustainable city.

A significant aspect of the project was the interactive web design that presented air quality data, green space expansion, clean energy growth, and bike-sharing trends in an intuitive and accessible manner. This not only made complex data more comprehensible but also helped underline the interconnected nature of the different sustainability efforts.
In conclusion, this project illustrates the positive impact of the OneNYC strategy in promoting sustainability in New York City. The improvement in air quality serves as a testament to the effectiveness of the integrated approach towards urban regeneration.

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Appendix

Contribution Table

Task Name	Major Contributors	Additional Contributors	Relevant Chapters in Report
“Project Overview”	Qiqi Liu		1
“Research Questions”	Qiqi Liu		1
Concept Development	Qiqi Liu	Ruyan Chen Yuting Xu Yucheng Li	1
Data preparation and integration	All team members		2
‘Home’ Page	Ruyan Chen		
‘About’ Page	Qiqi Liu	Ruyan Chen	2
Visualisation 1: Air Quality	Ruyan Chen		1,2,3
Visualisation 2: Green Spaces	Yuting Xu		1,2,3
Visualisation 3: Clean Energy	Qiqi Liu		1,2,3
Visualisation 4: Bike Sharing	Yucheng Li		1,2,3
Font Design	Qiqi Liu	Ruyan Chen	
Top Navigator Design	Ruyan Chen Qiqi Liu		
Colour Design	Ruyan Chen	Qiqi Liu	
Adaptability	Ruyan Chen		3
Web Typography	Ruyan Chen		3
“Summary”	Yuting Xu		4

Contribution List

Qiqi Liu (19119663)

Output:

About: https://digivisual-2023-group02.github.io/CASA0003/About.html

Clean Energy: https://digivisual-2023-group02.github.io/CASA0003/CleanEnergy.html

Font Design

Top Navigator Design

Report:

1 Introduction

- 1.1 Project Overview
- 1.2 Research Questions
- 1.3 Motivation
    - 1.3.3 Clean Energy

2 Process

- 2.1 “About” Page
- 2.4 Clean Energy

3 Technical Challenges

- 3.3 Clean Energy

Ruyan Chen (21188773)

Output:

Home: https://digivisual-2023-group02.github.io/CASA0003/Home.html

About: https://digivisual-2023-group02.github.io/CASA0003/About.html

Air Quality: https://digivisual-2023-group02.github.io/CASA0003/AirQuality.html

Colour Design

Top Navigator Design

Report:

1 Introduction

- 1.3 Motivation

1.3.1 Air Quality

2 Process

2.2 Air Quality

3 Technical Challenges

3.1 Air Quality

Yuting Xu (22078043)

Output:

Green Spaces:
https://digivisual-2023-group02.github.io/CASA0003/GreenSpaces.html

Report:

1 Introduction

1.3 Motivation

1.3.2 Green Spaces

2 Process

2.3 Green Spaces

3 Technical Challenges

3.2 Green Spaces

4 Summary

Yucheng Li (22070931)

Output:

Bike Sharing: https://digivisual-2023-group02.github.io/CASA0003/BikeSharing.html

Report:

1 Introduction

1.3 Motivation

1.3.4 Bike Sharing

2 Process

2.5 Bike Sharing

Data Sources

Bureau of Transportation Statistics:
Average Emission Rates -
https://www.bts.gov/content/estimated-national-average-vehicle-emissions-rates-vehicle-vehicle-type-using-gasoline-and

Citi Bike:
Bike Trip Histories - https://citibikenyc.com/system-data

New York State NYSERDA:
Clean Energy Industry Report -
https://www.nyserda.ny.gov/About/Publications/New-York-Clean-Energy-Industry-Report

NREL Documentation:
Alternative Fuel Stations -
https://developer.nrel.gov/docs/transportation/alt-fuel-stations-v1/all/#request-url

NYC Open Data:
1. Community Districts -
https://data.cityofnewyork.us/City-Government/Community-Districts/yfnk-k7r4
2. Green Spaces -
https://data.cityofnewyork.us/Recreation/Green-Spaces/mwfu-376i

NYCCAS Data Hub:
Air Quality - https://a816-dohbesp.nyc.gov/IndicatorPublic/beta/key-topics/airquality/