Resilience Planning in New York City

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Abstract

In recent years, academic interest in sustainable approaches to urban planning has increased but these approaches have not been used much in practice. Therefore, resilience planning, a sustainable urban planning approach, is used to research sustainability in New York City's sustainable policy document, OneNYC 2050. Like many cities, NYC deals with the negative effects of climate change, like urban flooding and heat stress. Therefore, this paper asks the question of to what extent resilience planning is used in NYC's sustainable policy documents. A literature review has been conducted which resulted in a set of indicators that are used to assess the presence of resilience planning in OneNYC 2050. Indicators that were developed during the literature review were ES, SES, biodiversity, coastal flood resilience, and extreme weather events. These indicators were then used in the document analysis to assess the presence of resilience planning. Some interesting findings were that in OneNYC 2050, very few (sustainable) coastal flood resilience measures are taken. Thus, more nature-based solutions were suggested where, for example, the strength of waves is reduced, causing them to be less powerful and protecting the shore from erosion to increase sustainable flood resilience. The City received a perfect score for their measures regarding extreme weather events on the other hand as both technical measures and knowledge systems for pluvial floods and heat stress were included in the policy document. To conclude, a resilience planning approach is present in OneNYC 2050, but improvements like nature-based solutions as mentioned before can be made.

Keywords: OneNYC 2050, resilience planning, sustainability, climate change

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Introduction

The effects of climate change are becoming a bigger problem all over the world. Droughts and extreme rainfall events are happening more frequently which negatively affects cities' services, for example, costly infrastructure, housing, and health (UN, no date; IPCC, 2022). Cities are also often seen as the cause of climate change as cities produce a lot of waste and emit the bulk of greenhouse gasses over the world. These aspects are closely related to sustainability and urban planning (Klopp and Petretta, 2017). Heymans et al. (2019) indicated that there has been an increase in interest in sustainable and ecological approaches in urban planning, however, these approaches have not been used much in practice. Therefore, they conclude that the negative impacts of urbanism will continue if ecological approaches are not implemented (Heymans *et al.*, 2019). However, Beheshtian et al. (2018) state that mitigation of the effects of climate change has been a concern of cities for decades and is often addressed by ecological sustainability policies (Beheshtian *et al.*, 2018, p. 1299). Therefore, this paper will research if sustainability is addressed in sustainability policies in New York City (NYC), where extreme weather events, rising sea levels and changes in temperatures caused by climate change are becoming more common. Next to these negative effects of climate change, NYC is a big city with a high number of residents which puts enormous pressure on the city and its ability to adapt to changes (NPCC, 2019). NYC, like one-third of the world's population, is in a coastal area, which is defined as an area within 100km of the coast (Barbier, 2015; Zhang *et al.*, 2018). The NYC case study could provide new insights that could be used in other (big) cities in coastal areas that deal with extreme weather events and anomalies in precipitation and temperature.

This research aims to assess the presence of resilience planning in the sustainable policy of NYC and draw general lessons that other cities can learn from. Klopp and Petretta (2017) discovered that the selection of indicators, localization and missing comparable data are the biggest limitations to making cities more sustainable. Therefore, the guidelines established in this paper will be used to assess the existence of resilience strategies in NYC's sustainable policy, OneNYC 2050 (OneNYC, 2019). Currently, there is limited knowledge of the actual implementation of sustainable policies in cities as discussed before (Beheshtian *et al.*, 2018; Heymans *et al.*, 2019). The central question of this paper is "To what extent is resilience planning used in the current sustainable policy of New York City and what general lessons can be learned from New York City?". This will be researched with the help of sub-questions which read as follows, "What are the indicators to assess resilience planning?" "Are the indicators present in OneNYC 2050?" and "What policy recommendation can be given to New York City?".

This research will first discuss the key terms mentioned in this paper. Secondly, the methodology will be explained, and a brief history of the policy document will be given to highlight the circumstances that led to the development of the policy. In the next chapters, the indicators will be explained and OneNYC 2050 will be analysed on the basis of these indicators. Lastly, a policy recommendation will be given.

Theoretical framework

Sustainability is given many different definitions, however, in this paper, the most used definition of sustainability will be used. This is the definition used in the Brundtland Commission Report (1987): "*development that meets the needs of the present world, without compromising the ability of future generations to meet their own needs*" (WCED, 1987). To add to this, sustainability is an incredibly broad topic as sustainability can relate to economic, social, and ecological sustainability. This paper will focus on ecological sustainability and the definition given by Starik and Rands (1995) is "*the ability of one or more entities, either individually or collectively, to exist and thrive (either unchanged or in evolved forms) for* *lengthy timeframes, in such a manner that the existence and flourishing of other collectivities of entities is permitted at related levels and in related systems*". This definition stresses, indirectly, the urge that sustainable development should not compromise the needs of future generations, but unlike the definition of the Brundtland Commission Report, this definition tries to focus on not only the anthropocentric elements (Starik and Rands, 1995, p. 909).

Within strategies for environmental sustainability is the concept of resilience planning. There are two definitions of resilience used in the urban context and the older version, focuses on returning to equilibrium. The newer definition, however, focuses on *"[adapting] while sustaining its fundamental structure and function*". This definition, where an equilibrium is never reached, is more applicable as cities are dynamic. However, there are also difficulties with this approach as humans are not always included while they are part of the ecosystem and therefore must be included to produce positive outcomes (Heymans *et al.*, 2019). Resilience planning takes the definition of resilience where an equilibrium is never reached and allows for safety margins to minimize the effects of a crisis or disaster. To minimize these effects, resilience planning should focus on all aspects of disaster management as disasters are not always preventable, so it is important to not only focus on proactive measures but also on reactive measures. By expecting a crisis and taking measures to reduce the effects, this approach is well-suited for future-proofing cities as it is likely that due to climate change, more crises will occur (Sharifi and Yamagata, 2018). Resilience planning is best achieved through action plans. These plans focus on what action should be taken by whom, and in what order (EFC, 2020).

Resilience planning can be linked to spatial aspects and sustainability aspects (Heymans *et al.*, 2019). An example of a spatial aspect is coastal flooding. Due to rising sea levels and the increase in extreme weather events, floods occur more frequently, especially in low-lying coastal areas (Bates *et al.*, 2021). To assess if measures against flooding are included in policy documents, indicators like the presence of protection measures like dams, reducing flood consequences, and adaptive flood risk management strategies can be used. Adaptive flood risk management strategies focus on spatial measures like retention areas and on adaptation through raising awareness and working together with stakeholders (Laeni, van den Brink and Arts, 2019). The latter also corresponds with the sustainability indicators, such as the socio-ecological systems (SES) theory. SES is the cooperation between different stakeholders or departments of the city council to create more effective plans (Heymans *et al.*, 2019).

Other indicators that will be discussed in the chapter "Indicators for resilience planning" are ecosystem services (ES), biodiversity loss, and extreme weather events (Heymans *et al.*, 2019). These variables test which aspects of resilience planning are present in the plan and more important, which aspects are not present in the plan. With this newly generated information, a policy recommendation can be given and the central question, "To what extent is resilience planning used in the current sustainable policy of New York City and what general lessons can be learned from New York City?", can be answered.

Conceptual model

As stated before, resilience planning has spatial and sustainable indicators. Within these categories, indicators have been established (*Figure 1*). These indicators will be used to assess the extent of a resilience planning approach in OneNYC 2050, NYC's sustainable policy. After the evaluation of OneNYC 2050, a policy recommendation is given.

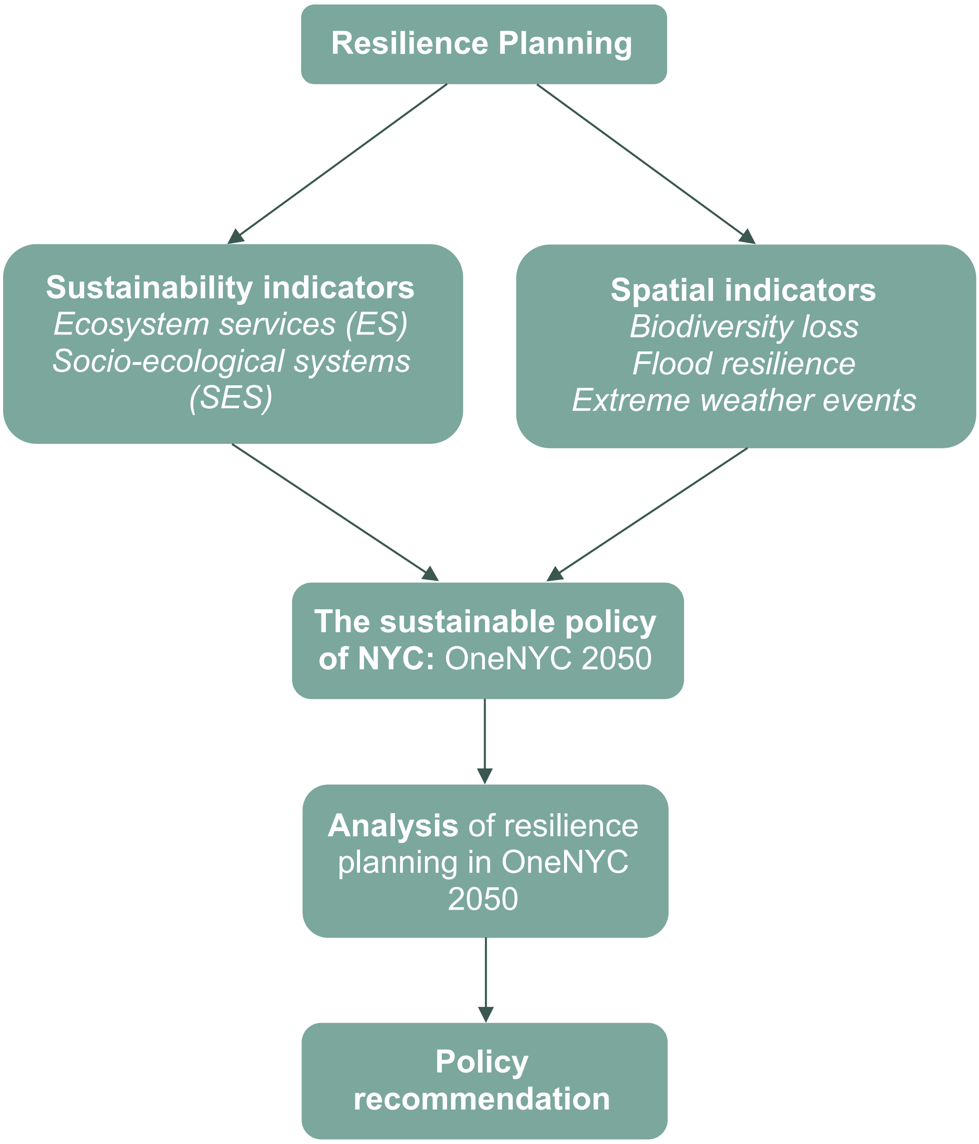

Figure 1: Conceptual model

Methodology

To answer the central question, this paper will first specify the indicators for resilience planning. To be able to identify these indicators, literature on what is already known is necessary and as a literature review aims to provide an overview of what is already known, this is seen as a suitable method (Snyder, 2019). These identified indicators will be utilized to analyse the extent of resilience planning in OneNYC 2050. A document analysis is used for reviewing documents and would therefore be a suitable method to review and analyse OneNYC 2050 (Bowen, 2009). In the document analysis, resilience planning is identified in the policy document by marking sections. Each indicator has two to five specific elements to which marked sections can be linked in ATLAS.ti (*Figure 2*). These elements will be explained in detail in the chapter "Indicators for resilience planning". After connecting the policy document to the indicators, OneNYC is evaluated with the help of a scoring scheme. Each of the five indicators can receive a total of 20 points, the amount depending on the number of elements included in OneNYC

2050, and after adding up the points rewarded to each indicator, a final score is reached (*Appendices 1 and 2*).

The final product will be a policy recommendation based on the document analysis as the analysis will point out the elements of resilience planning that are present in OneNYC 2050, and therefore, elements that are not present could be included in an updated version of the policy.

Data Analysis Scheme

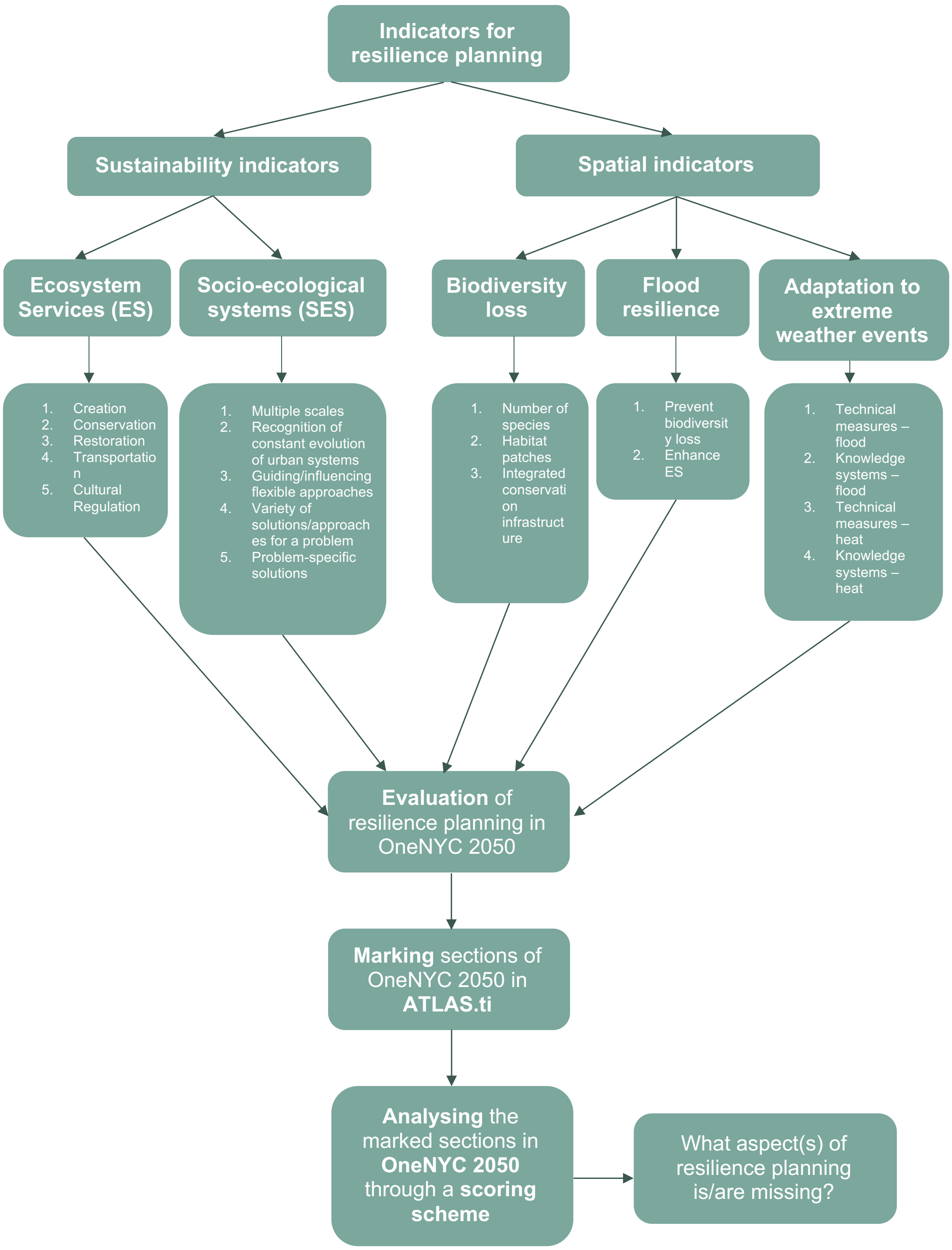

Figure 2: Data Analysis Scheme

History of OneNYC 2050

OneNYC 2050 is the successor of PlaNYC. PlaNYC was established in 2007 to accommodate the population growth in NYC and aims to have a proactive approach instead of a reactive approach all while also focusing on environmental sustainability (The City of New York, 2007). In 2015, PlaNYC was replaced by OneNYC 2050 which aims to deal with climate change. This aim was likely due to Hurricane Sandy which hit NYC in 2012 and left severe damage (The City of New York, 2019, p. 4). The hurricane caused the tide to rise by several meters and increased rainfall which both caused severe floods (NYCEDC, 2019). 7 years after the hurricane, coastal protection plans were developed in the form of the Lower Manhattan Coastal Resiliency Plan as Manhattan was damaged most by Hurricane Sandy (The City of New York, 2019)

There are some concerns about this policy as environmental experts and civil leaders pointed towards the many aspects of the policy that remained vague and not well explained (Flegenheimer, 2015). This concern is not unjustified considering NYC's history. OneNYC 2050 is, like previous policies in NYC, a strategic vision document which means that there are no budgets included in the policy and the aim of the document is convincing stakeholders or residents to join their plans. These plans can have very good results, for example, the ten-year housing plan of 1985 (Schill *et al.*, 2002). But there are also examples where this approach did not work as is visible in NYC's plan to expand the subway system in 1929 where last-minute, plans fell through (NYC Subway, 1997). This dependency on stakeholders can be detrimental to a plan.

OneNYC 2050 consists of 9 chapters, one introductory chapter and eight chapters each focusing on a different goal. As not all goals apply to this research, only chapters 3, 4, 6, 7 and 8 will be researched. These chapters focus on the goals of thriving neighbourhoods, healthy lives, liveable climates, efficient mobility, and modern infrastructure respectively (The City of New York, 2019).

Indicators for resilience planning

As stated before, indicators to assess resilience planning can be divided into two categories: sustainability and spatial indicators. Sustainability indicators focus on the interactions which could improve the effectiveness and coordination of sustainability initiatives while spatial indicators focus on the measures taken in the spatial dimension to become more sustainable and climate resilient (Heymans *et al.*, 2019). The following section will discuss these indicators and to see the scoring scheme in more detail, see Appendix 1.

Sustainability indicators

In this research, two sustainability indicators are considered, ecosystem services (ES) and socio-ecological systems (SES), which will be discussed in the following paragraphs.

Ecosystem services are defined as "benefits the human population derives, directly or indirectly, from biodiversity and ecosystem functions" (Heymans *et al.*, 2019, p. 8). These benefits are often categorized into four types, provisioning, regulating, supporting, and cultural benefits (Heymans *et al.*, 2019). However, these benefits focus only on nature-to-human relationships and therefore Wang et al. (2009) added another type of benefit where the focus is on human-to-nature relationships. The categories are production, construction, restoration, transportation, and cultural regulation. The first three categories (production, construction, and restoration) are about ecosystems in general while the latter two (transportation and cultural regulation) focus on more specific elements of an ecosystem. Transportation, for example, can relate to the energy or water cycle and cultural regulation focuses on institutional enforcement and eco-tourism. Considering these human-to-nature relationships, ES's presence can be measured through the creation, restoration, conservation, transportation, and cultural regulation of ecosystems (Wang *et al.*, 2009).

Socio-ecological systems theory can be defined as "a complex adaptive system, which is characterized by many autonomous parts, interacting dynamically in non-linear relationships and at multiple scales with the ability to self-adjust in response to change" (Heymans *et al.*, 2019, p. 9). An important aspect of the SES theory is the awareness of the constant evolution of urban systems. As the urban environment is in constant evolution, a technical approach where everything in the urban environment is fixed does not work. Instead, guiding and influencing systems or processes is a more effective approach to reaching a more sustainable and resilient city (Pickett *et al.*, 2014). Therefore, elements of SES are the multiple scales, recognition of the constant evolution of urban systems, guiding/influencing flexible approach, the presence of a variety of approaches, and solutions for a problem and making problem-specific solutions contexts (Heymans *et al.*, 2019).

Spatial indicators

Three spatial indicators are used in this research: fighting biodiversity loss, flood resilience, and adaptation to extreme weather events. These indicators will be explained in more detail in the next paragraphs.

The first spatial indicator is fighting biodiversity loss. Heymans et al. (2019) define biodiversity as 'the variability of, and the complex interactions between, living species, genetic material and ecosystems' (Heymans *et al.*, 2019, p. 10). This definition shows that biodiversity is not only about species numbers or what species to keep but is about species and the environment interacting and influencing each other. There are currently two approaches in spatial planning to fight biodiversity loss. The first approach focuses on creating separate habitat patches such as wetlands, or urban forests. However, this approach ignores other, smaller, urban areas that have the potential to increase urban biodiversity. Therefore, another approach was developed that was less focused on species numbers and more on an integrated conservation infrastructure such as the connections between different habitat patches. The second approach is an important element for the biodiversity indicator. The creation of biodiversity patches alone will not be enough, connections between areas must be made to avoid the island effect where species cannot survive due to isolation (Heymans *et al.*, 2019). Elements of the indicator are the number of species, habitat patches, but also integrated conservation infrastructure.

The second spatial indicator is flood resilience. Sea levels are rising due to increasing temperatures and increased rainfall, making NYC more prone to flooding. This indicator for flood resilience will only focus on coastal flooding as pluvial flooding will be discussed in the next paragraph as pluvial flooding relates to the increase in extreme weather events (Rosenzweig *et al.*, 2018). Solutions to adapt to coastal flooding have been developed from an engineering point of view with the main purpose to protect citizens. However, these solutions did not take ecology in mind and therefore a second type of solution was developed, a solution where technical measures are adapted to prevent biodiversity loss and enhance ES. For the flood resilience indicator, solutions have to prevent biodiversity loss and enhance ES to be sustainable and be able to be resilient in the future (Borsje et al., 2011).

The last spatial indicator is adapting to extreme weather events. An example of extreme weather events is heavy rainfall, and this can lead to pluvial flooding. This indicator has quite some overlap with the indicator for flood resilience, however, this indicator only focuses on flooding due to extreme weather. Most urban drainage systems are developed for 'design' storms where the intensity and duration of rainfall are predicted based on historical information. However, extreme weather events that exceed the limits of the 'design' storm have been occurring more frequently (Rosenzweig *et al.*, 2018). Solutions to these events are often technical, for example, blue-green roofs, open spaces for water storage and porous pavement so water can infiltrate into the soil (Al-Busaltan *et al.*, 2021; Busker *et al.*, 2022; Jongen *et al.*, 2022). But this is not the only type of solution to help prevent pluvial flooding, knowledge systems can also help to improve the technical solutions by allowing stakeholders to learn and adapt systems. This way solutions are not set in stone and can be re-assessed after an extreme weather event occurs to reduce exposure and vulnerability when the next extreme weather event occurs (Rosenzweig *et al.*, 2018). The continuous adaptation of technical measures through knowledge systems is also applicable to droughts and extreme heat and the technical measures to prevent and reduce the negative effects of floods can also reduce the negative effects of droughts and extreme heat. An example of this is the open spaces which can hold water during storms but can also provide water during droughts and the blue-green roofs that can hold water and cool down the City (Güneralp, Güneralp and Liu, 2015; Rosenzweig *et al.*, 2018). Therefore, elements of the extreme weather events indicator are the technical measures for floods and for heat, and the knowledge systems in place for adaptation of approaches when floods or extreme heat occurs.

Analysis of OneNYC 2050

The policy, OneNYC 2050 will be assessed based on the number of elements that are present in the policy. The indicators and scores for OneNYC 2050 will be discussed in the next paragraphs (*Appendix 2*).

Sustainable indicators

OneNYC 2050 receives a good score for the indicator, Ecosystem Services (*Table 1*). The plans for the City include the creation of new natural areas which are visible in the Community Parks Initiative, Parks Without Borders, Anchor Parks and other neighbourhood investments that propose the creation of new natural areas (*Figure 3)*. Restoration of ecosystems is also widely talked about in OneNYC, for example through wetland and forest restoration or the Jamaica Bay Improvements Project. In the latter, invasive plant species will be removed, and native

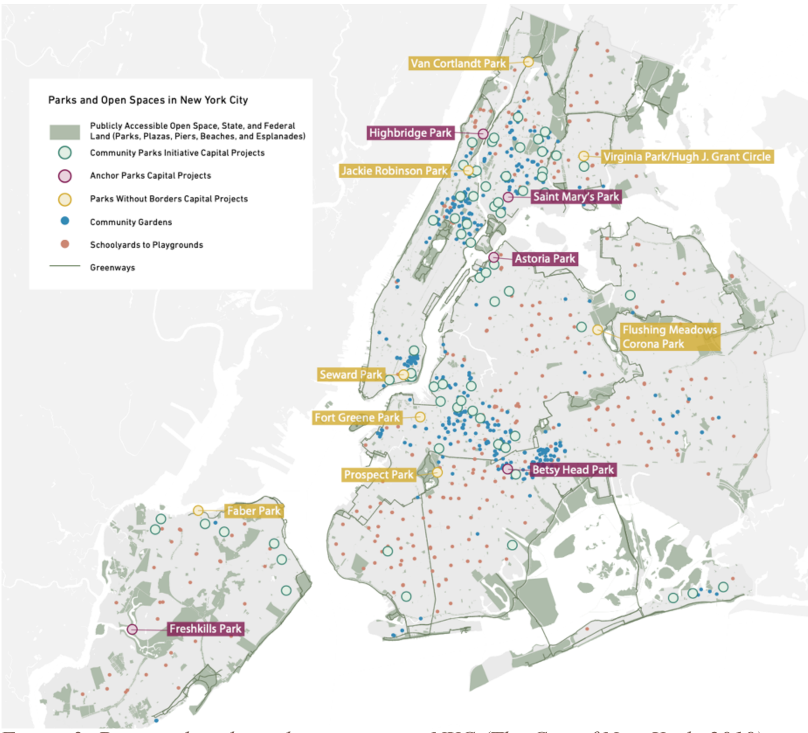

Figure 3: Proposed parks and greenways in NYC (The City of New York, 2019)

maritime species will be planted. The conservation of ecosystems is not mentioned as often as the creation or restoration of ecosystems. Conservation is only mentioned once, as NYC aims to manage the trees in the streets and parks or as it is called by the City: the urban forest. But the City does not have specific measures yet on how to conserve the urban forest except for cutting down dead trees or sick trees so they will not infect other, healthy trees (The City of New York, 2019).

Transportation was also an element of ES, and this element is included in the policy plans of NYC. An example of this is their aim to have 100 per cent clean energy and fully electrify the City. The City plans to do this by establishing wind farms upstate and offshore and by rooftop solar energy generation. For the current energy grid to deal with this energy, the grid will be updated and able to store more renewable energy. However, they show no indication of having these plans consulted with communities living upstate, where the City plans to build wind farms. Water recirculation projects are another example of transportation in OneNYC 2050. As drinking water is often used for purposes where lower quality water also would have been adequate, think of irrigation or refilling lakes, projects for example in Central Park were introduced. In these projects, recycled water will be partly used to replace drinking water. The last element of ES was cultural regulation. However, this was not mentioned in the policy which could be because NYC does not deal with ecotourism (The City of New York, 2019).

The City receives a good score for the indicator Socio-Ecological Systems as all elements are present in OneNYC 2050 (*Table 1*). Many of the solutions come forth from collaboration on multiple scales, mainly the collaboration between the City and the residents and local communities. An example of this is the integrated neighbourhood planning initiatives from the Department of City Planning. Through these initiatives, residents and other stakeholders are invited to think with planners and other experts about the plans and in some cases, this has led to additional plans or minor changes in plans. Another example of collaboration between the City and residents is the Lower Manhattan Coastal Resiliency Plan where decisions will be made through a public engagement process. However, residents are often only included in the beginning stages of a plan or initiative and sometimes the plans just tell the residents what is happening. To illustrate this, the City wants to deploy more wind and solar energy. They propose wind turbines upstate but in the policy document there is no indication that the communities living there actually want those wind farms. The same thing applies to solar energy as not everyone can afford solar panels or wants solar panels on their roof (The City of New York, 2019).

There is also much collaboration between the City and other stakeholders, for example, for the energy grid extension where NYC works together with New York State and energy authorities and infrastructure operators in New York. But there is also cooperation between the City and non-governmental organisations as is illustrated in the Solar Uptown Now Campaign where two non-profits, Solar One and Urban Homesteading Assistance Board worked with the City to build solar and heat pumps on affordable housing in NYC (The City of New York, 2019).

However, recognition of the constant evolution of urban systems is only visible when OneNYC discusses the effects of climate change. With the evolution of climate science, the City can help architects and engineers by integrating climate change models into their designs but there is no recognition of changing urban systems because of societal changes like changing wants and needs in the community. This can affect the resiliency of the City as people's vision of climate change can change and how they see a resilient City. Therefore, NYC will not receive full points for this indicator (The City of New York, 2019).

OneNYC 2050 includes many guiding and flexible approaches. Most noteworthy are the steps that residents can take at the end of each chapter of OneNYC 2050 to help the City.

These suggestions are often explained in much detail reducing obstacles for residents. To illustrate this, in the chapter promoting a liveable climate in NYC, there is a step that explains in detail how residents can learn about their flood risk. For example, by visiting the website of FloodHelpNY where they can receive customized information based on their location. All these steps provide the citizens with enough information that they are likely to follow these steps but not that they feel forced to do so (The City of New York, 2019).

Next to the guiding and flexible approaches, the document also includes a variety of approaches or solutions for a single problem. An example of this is increasing mobility by reducing traffic congestion, modernizing subway systems, and increasing bus performance. These three measures deal with three different issues in the current mobility problems of NYC. Other examples are the many measures in place to deal with heat and pluvial flooding which will be expanded upon later. All of the solutions in OneNYC are made to fit a particular problem. This relates to the first element of SES discussed, which was the usage of multiple scales and the collaboration between city and local communities. These local communities know what is going on in an area and provide location-specific information which makes these solutions problem-specific (The City of New York, 2019).

Spatial indicators

Measures that increase biodiversity are much discussed in OneNYC 2050. Increasing habitat patches is done through initiatives where, for example, credits are issued when new forests are planted and through the restoration of forests and wetlands. All these measures will indirectly increase biodiversity. Integrated conservation infrastructure can also be achieved indirectly, through for example the Forest Management Framework where trees are planted in areas where more green is needed and therefore has the potential to connect habitat patches. There are also measures where integrated conservation infrastructure is directly achieved for the purpose of connecting nature areas. Examples of this are the Community Parks Initiative, Parks Without Borders, Anchor Parks, and other neighbourhood investments that next to proposing new parks and other nature areas, also propose greenways that connect parks with each other. However, there are no plans to connect these newly proposed nature areas (The City of New York, 2019).

New York City also recognizes the many open spaces in the City which are comprised of vacant lots, areas under highways and bridges, and streets and aims to improve them. This is done through Vision Zero street-improvement projects where more greenery is included in the streets. But nothing is mentioned about what to do with the vacant lots, which can be part of the integrated conservation infrastructure (The City of New York, 2019).

However, there are no measures to specifically prevent biodiversity loss and the decrease in species numbers. The habitat patches and the integrated conservation infrastructure mainly focused on preventing negative health effects experienced by humans from climate change or improving social life and not increasing biodiversity. This is for example visible in the chapter on healthy lives where is stated that ‘green infrastructure softens the city’s built environment, naturally absorbing stormwater’ (The City of New York, 2019, p. 27). Therefore, OneNYC 2050 will receive a good score for the biodiversity indicator (*Table 1*).

Very few measures in NYC’s policy document OneNYC 2050 deal with coastal flood resilience and therefore there are also few measures dealing with enhancing ecosystem services and preventing biodiversity loss. Because of this, NYC receives a moderate score for the indicator flood resilience (*Table 1*). Of the two elements assigned to this indicator only one, the enhancement of ecosystem services, was mentioned. This is mentioned in, for example, the Lower Manhattan Coastal Resiliency Plan to extend the shoreline of Manhattan and create high points on this newly created land. However, this plan was still in the making at the time of the publication of the policy and no actual measures were set on how to do this except that it should be done through multiple solutions and, as mentioned before, that the public will have a say in the measures that will be implemented. Apart from the Lower Manhattan Coastal Resiliency Plan, no concrete plans are mentioned. Nature-based solutions mitigating risks caused by climate change are mentioned, however, this is an unclear measure as they do not go into depth on how they will do this (The City of New York, 2019).

NYC receives an excellent score for resilience planning when it comes to extreme weather events as technical measures and knowledge systems for both coping with floods and heat are present (*Table 1*). Technical measures proposed in OneNYC that help to cope with heat are covering buildings' roofs in heat-vulnerable areas with reflective materials. This will increase the albedo and reduce high temperatures and negative health effects. Another solution mentioned in the document is expanding the tree canopy which provides residents with shade and the light and heat of the sun get reflected to the troposphere again. This is done through the Forest Management Framework where trees are planted in areas that are vulnerable to heat. The Forest Management Framework is not only useful for mitigating the negative effects of heat but also for mitigating the negative effects of floods as trees naturally store rainwater. This relieves some pressure on the sewage systems. Other programs to reduce the negative effects of floods are 'Adopt-a-Rain Garden' and the expansion of the Mid-Island Bluebelt and the creation of blue belts in other parts of NYC where the blue belt receives and filters stormwater (The City of New York, 2019).

The knowledge systems for floods and heat mitigation are not separated into these categories but are more general and deal with all of the effects of climate change which does not only include pluvial flooding and heat stress. Here the focus is reactive and proactive as the City plans for constant improvement and studying of the recovery plans but also strengthens guidelines for the construction of new buildings or infrastructure to be more climate resilient. But the element of learning is less present in the knowledge systems (The City of New York, 2019).

Table 1: Resilience planning scores received by OneNYC 2050

Indicator	**Points received (max. 20 points)**
Ecosystem Services (ES)	16 (good)
Socio-Ecological Systems (SES)	16 (good)
Biodiversity	16 (good)
Flood resilience	12 (moderate)
Extreme weather events	20 (excellent)
Total	**80 (good)**

Policy recommendation

In the previous chapter, OneNYC 2050 was discussed, and the policy document received 80 out of 100 points which is a good score. However, that also means there is room for improvement when it comes to resiliency. In this chapter, missing elements of resilience planning in OneNYC will be addressed and suggestions for each indicator will be made to improve the policy document.

OneNYC 2050 did not receive full points for the indicator ecosystem services. As mentioned before, this is because the policy document does not include plans for cultural regulation. This could be because there is no ecotourism in NYC, but that does not mean that tourism does not put pressure on ecosystems. In 2019 were over 66 million tourists which is almost 8 times the number of residents in the City, and this has negative effects on the City (U.S. Census Bureau, no date; New York State Comptroller, 2021). Examples of these effects are the waste littering around major tourist activities which can cause the death of animals living in the City, but also trampling on vegetation in parks in NYC. Walking over the same path, again and again, can cause plants to break or die and it can cause the soil to lose organic matter (Sunlu, 2003).

Therefore, it is advised to distribute tourism over a bigger area, not only the City. To illustrate this, the Netherlands already has been doing this through HollandCity where destinations in the Netherlands other than Amsterdam are highlighted. For example, at Schiphol Airport there have been campaigns to visit the Hague to reduce the number of tourists visiting Amsterdam and therefore also reduce the pressure on the urban system (Sibrijns and Vanneste, 2021). Next to spreading tourism over the whole country, Amsterdam also has a limit of 20 million visitors per year (City of Amsterdam, no date). This policy document is something NYC could also look at when reducing tourism to improve local ecosystems.

The policy document also did not receive full points for the socio-ecological systems indicator. The reason for this is the lack of recognition of changes in population and therefore wants and needs regarding sustainability and resiliency. So, advice for NYC is to incorporate (future) residents' wants and needs and this can be achieved through public participation. This can also benefit the collaboration between the City and local communities and residents as they are often not included in every step of project development when they could be. Some advantages of using public participation are making better decisions because of the additional input of information and the interests of all stakeholders are considered (EPA, no date).

Policy advice for the indicator of biodiversity has to do with the lack of measures to prevent biodiversity loss. The other two elements for this indicator were achieved indirectly, the aim of those measures was not to increase biodiversity but often to reduce heat stress or prevent flooding. However, measures developed specifically for increasing biodiversity are also important as high biodiversity can help with predicting climate change effects and measures can be taken to mitigate these effects as much as possible (Dearborn and Kark, 2010).

Even though OneNYC 2050 received points for integrated conservation infrastructure, there is still room for improvement. As previously stated, greenways are implemented to mitigate the negative effects of heat, but they also provide a connection between different parks. However, not all the newly proposed parks by the Community Parks Initiative, Parks Without Borders, Anchor Parks, and other neighbourhood investments are connected to each other via greenways. This could be improved because linking the parks with natural areas, would make the habitat patches bigger and therefore able to support a higher number of species (Kozlov and Zverev, 2022). Therefore, the advice is to look for the implementation of more connections between parks and other habitat patches.

OneNYC 2050 mentions very few measures that deal with coastal flood resilience. This makes it more difficult to give specific policy recommendations that focus on sustainability and resilience. The policy document mentions nature-based solutions this would enhance ES and biodiversity. However, the policy document did not go into further detail on what these nature-based solutions should look like. Morris et al. (2018) concurred with NYC that engineering-based solutions are becoming unsustainable, ecologically, and economically. Therefore, they also propose nature-based solutions. They see those measures implemented as the deposition of sediment, increase in bed friction and building of biomass as these measures change shore profiles, elevation in relation to sea level, and wave attenuation which reduces coastal erosion. These measures would also be beneficial for ecosystem services as they increase the habitat which could lead to higher biodiversity and they have the potential to adapt to climate change unlike engineering measures (Morris *et al.*, 2018). This is something NYC could try to implement; however, further research is necessary to see where these measures could be realized.

Receiving an excellent indicator score does not mean there is no room for improvement. In the case of extreme weather events, improvements could be made to the knowledge systems as the element of learning is not fully present as NYC currently focuses mainly on learning by improving technical measures. However, by involving the public, not only residents but also local businesses who, for example, often do not have flood insurance, the City could improve knowledge systems as the public can provide useful input for more social measures after a disaster has struck. An example of this could be mandatory flood insurance (Rosenzweig *et al.*, 2018).

Conclusion and Discussion

Sustainability is getting increasingly important in urban planning and there are different approaches to increase sustainability in cities. Resilience planning is one of those approaches and focuses on the adaptation and mitigation of the negative effects of climate change which is necessary for a city to keep thriving. Therefore, the research question was: "To what extent is resilience planning used in the current sustainable policy of New York City and what general lessons can be learned from New York City?". The aim was to assess the presence of resilience planning in the sustainability policy of NYC, OneNYC 2050, and draw general lessons from this. NYC has a history of developing strategic vision plans and some have had massive successes, while other plans did not turn out all too well. Action plans that lay out what needs to be done by whom and when are most effective and therefore, indicators to assess resiliency in OneNYC 2050 are ecosystem services, socio-ecological systems, biodiversity, coastal flooding, and extreme weather events.

NYC received a good score of 80 out of 100 points for their climate resiliency policies and therefore recommendations are given for each of the aforementioned indicators. Tourism could be redistributed or regulated similarly to Netherlands' approaches to improve ES. Increased public participation could be used to improve SES and knowledge systems. For example, after a disaster has struck, public participation could help the City learn from the disaster on a local level. Integrated conservation infrastructure was mentioned in the policy document; however, not all newly proposed parks will be linked via greenways. There were few measures that discussed coastal flooding therefore it is recommended that nature-based solutions are implemented. Other (coastal) cities can also learn from NYC, for example, looking at NYCs measures that reduce the effects of extreme rainfall or heat as these got maximum scores in OneNYC 2050, and adapting them where necessary.

This research focused in detail on OneNYC 2050. Therefore, other plans, not mentioned in OneNYC 2050, could reveal information that would change the score of climate resiliency in NYC. This could be further investigated. Future research could also look into the effectiveness of the policy document which did not fall in the scope of this paper.

Greenhouse gases were mentioned quite often in OneNYC 2050. This is, however, not used as an indicator of resilience planning. Therefore, it would be useful to look into other elements of OneNYC 2050 that aim to prevent climate change and how this compares to the measures taken to adapt to climate change through resilience planning.

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Appendix 1 – Empty scoring scheme

Indicator	Poor - 4	Fair - 8	Moderate - 12	Good - 16	Excellent – 20	Score	Missing elements
Ecosystem Services - Elements: creation, conservation, cultural regulation, restoration, transportation	Includes none of the elements	Includes one or two elements	Includes three elements	Includes four elements	Includes all elements		
Socio-Ecological Systems - Elements: multiple scales, the constant evolution of urban systems, guiding/influencing flexible approaches, variety of approaches/solutions, problem-specific solutions	Includes none of the elements	Includes one or two elements	Includes three elements	Includes four elements	Includes all elements		
Biodiversity - Elements: number of species, habitat patches, integrated conservation infrastructure	Includes none of the elements	-	Includes one element	Includes two elements	Includes all elements		
Flood Resilience - Elements: prevent biodiversity loss, enhance ES	Includes none of the elements	-	Includes one element	-	Includes all elements		
Extreme Weather Events - Elements: technical measures against floods, technical measures against heat, knowledge systems against floods, knowledge systems against heat	Includes none of the elements	Includes one element	Includes two elements	Includes three elements	Includes all elements		

Appendix 2 – Scoring scheme OneNYC 2050

Indicator	Poor - 4	Fair - 8	Moderate - 12	Good - 16	Excellent – 20	Score	Missing elements
Ecosystem Services - Elements: creation, conservation, cultural regulation, restoration, transportation	Includes none of the elements	Includes one or two elements	Includes three elements	Includes four elements	Includes all elements	16	Cultural regulation
Socio-Ecological Systems - Elements: multiple scales, the constant evolution of urban systems, guiding/influencing flexible approaches, variety of approaches/solutions, problem-specific solutions	Includes none of the elements	Includes one or two elements	Includes three elements	Includes four elements	Includes all elements	16	Constant evolution of urban systems
Biodiversity - Elements: number of species, habitat patches, integrated conservation infrastructure	Includes none of the elements	-	Includes one element	Includes two elements	Includes all elements	16	Number of species
Flood Resilience - Elements: prevent biodiversity loss, enhance ES	Includes none of the elements	-	Includes one element	-	Includes all elements	12	Prevent biodiversity loss
Extreme Weather Events - Elements: technical measures against floods, technical measures against heat, knowledge systems against floods, knowledge systems against heat	Includes none of the elements	Includes one element	Includes two elements	Includes three elements	Includes all elements	20	-