

Urban Resilience – the Fight for a Better Future

Flood-risk management in leading cities of the environmental sustainability
field

– The cases of London and Vancouver –

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Abstract

Urban resilience is a method that recently emerged within the field of sustainable development. Through resilience-building, leading cities within this field, such as London, UK and Vancouver, CA, can become resistant to the effects of climate change, such as the increased flood risk. This research focuses on the ways in which London and Vancouver strive to become flood-resilient through policy-making.

A document analysis of London and Vancouver's climate change adaptation strategies, progress reports and updates on them, and other related documents is conducted to determine the two cities' success at building resilience throughout the last decade. This is done by exploring the presence of policy dimensions (economic, environmental, social, infrastructure and institutional) and indicators within the documents.

It has been concluded that both London and Vancouver have made efforts to become more flood-resilient. The process relies on improving and developing their infrastructure as well as further producing plans of how to manage the flood-risk in the future. However, Vancouver tends to simultaneously built resilience across multiple sectors, as indicated by policies that pertain to all dimensions, while London focuses solely on improving and developing new infrastructure and flood defenses. Additionally, neither city uses the full potential of policy indicators, therefore the impacts of their climate change adaptation strategies on resilience-building cannot be fully determined.

1. Introduction

1.1. Background

Climate change is a phenomenon that includes global warming driven by human emissions of greenhouse gases resulting in large-scale shifts in weather patterns. These patterns affect the quality of life throughout the entire world and, since the mid-20th century, they have increasingly created issues that threaten the planet's future. Therefore, measures to mitigate and/or adapt to climate change are needed at a global level. Within this thesis, the primary focus will be on one specific method of adapting to climate change, urban resilience.

Urban resilience is a concept that has recently become prominent in the context of sustainable development. The need for urban resilience emerged when the socio-ecological systems and their sustainable management became affected by the negative effects of climate change on the world at large. The term "resilience" has been gaining ground in urban sustainability literature. Furthermore, "resilience" has started being integrated within the field of policy-making as well (Meerow, Newell, & Stults, 2016). "Resilience", paired with the urban aspect, has drawn the attention of both policy-makers and the scientific community. Adopting adaptation measures is now critical for tackling the impacts of climate change (Meerow et al., 2016).

Resilient cities' role is to build resistance to better handle natural and human-made disasters, to protect human life, to absorb the impact of economic, environmental and social hazards, and promote well-being and inclusive as well as sustainable growth. Cities going through a constant process of change and evolution, physically, socially, and politically, trigger the need for plans of bouncing back in case the development falters, be it because of natural or human-made incidents. Moreover, urban resilience also encourages and requires a high level of coordination across multiple governance levels and between government, various industries and humanitarian organisations. Hence, building urban resilience within the world's cities is not relevant solely for the good of a specific city, but it becomes an effort that concerns the entire world.

Recent literature within the sustainable development domain enunciates various methods of urban resilience-building, distinct approaches of determining the urgency at which urban resilience needs to be taken care of, multiple pointers towards what the main focus of building urban resilience should be given the predominant issues of the region and/or city in question (Figueiredo, Honiden, & Schumann, 2018; Sanchez, Van der Heijden, & Osmond, 2018; Sharifi & Yamagata, 2014; Tyler & Moench, 2012). As such, the literature provides a comprehensible understanding of what the problems and actions should be, yet, only in the past

few years, actions for urban resilience-building have truly occurred. Therefore, not much information exists within literature as to how effective urban resilience-building has been since there is “little research on the development of tools for assessment of urban resilience” (Sharifi & Yamagata, 2014, p. 1492). However, cities engaged in building resilience provide updates and reports on how well their strategies are functioning by presenting several tools used. Updates and reports also inform about alterations that should be implemented for achieving better results.

This paper aims to produce a better understanding of what policies and actions cities seeking to build urban resilience create and implement by analysing the climate change adaptation strategies (CCASs), progress reports and action plans of two leading cities in the field of urban resilience, London, United Kingdom (UK) and Vancouver, Canada (CA). In this context, urban resilience is part of CCASs’ goals which, in turn, are interconnected with environmental policies. As both London and Vancouver are under threat of being flooded – climate change affects weather patterns which will cause increased rainfall and the rise of the sea level –, CCASs and other documents containing action plans set for building resilience against floods become the focus of the analysis presented within this paper.

It is relevant to look into both London and Vancouver since they face similar as well as distinct flooding threats: London has to deal with three major flooding scenarios, tidal, fluvial and surface water flooding, whilst Vancouver is threatened by coastal and surface water flooding. Both cities’ policies for building resilience against floods are worth analysing as how resilience is built differs on the type of flooding threat and available resources. Therefore, London is prone to accomplishing resilience against fluvial flooding differently than Vancouver is building resilience against coastal flooding. The ways in which building resilience against flooding is handled in the cases of London and Vancouver can be seen as complementary. Thus, by gaining information about practices for all flood types, a complete picture can be constructed of how the cities can become more resilient.

1.2. Research Question

Based on the aforementioned information, this paper will present a description of urban resilience within the context of the flood risk brought around by climate change, how urban resilience can be monitored and strengthened, and the role policy-making plays in this endeavour. This description will aid in understanding how the strategies, policies and action plans regarding urban resilience-building at the local level can be improved. Several cities of the world are considered leaders in taking action for combating climate change, such as London

and Vancouver (C40, n.d.-a). Hence, this research aims to answer the research question: “*How can leading cities in the field of environmental sustainability, such as London and Vancouver, become more resilient to climate change?*”.

In order to answer the research question, three sub-questions guide the research process:

- To what extent does the need for climate change adaptation shape the policies for London, respectively Vancouver?
- What are the indispensable elements climate change adaptation strategies must have?
- What are the common limitations to climate change adaptation strategies?

The first sub-question is going to be addressed and answered by conducting a thorough analysis on the policies designed, implemented or soon-to-be implemented in both London and Vancouver using CCASs, progress reports and other related documents. This analysis will lead to a better comprehension of the actions required to build resilience within a city. The second and the third sub-questions will be answered using the policy indicators theory for measuring urban resilience. The necessary elements and limitations of the strategies will be determined on the basis of their capacity to act on the various dimensions encompassing policy indicators. Conversely, the policy indicators will also indicate where a specific city may be lacking behind in its resilience strategy.

1.3. Scientific and Social Relevance

In terms of scientific relevance, the study is meant to provide insight into how good policies and action plans can contribute to improving urban resilience. Policies can be argued to be the foundation for communities to achieve their greatest potential through common effort, hence climate change policies become indispensable instruments for building urban resilience. Furthermore, in order to obtain an in-depth understanding of the key role policies have in building resilience, the requirement of monitoring and assessing climate change adaptation policies and actions is emphasised. Methods through which this can be achieved are presented.

Socially, this research raises awareness about the climate change threats and provides information about the efforts for climate change adaptation and building urban resilience. Moreover, the research emphasises the need of a unified approach for climate change adaptation at the local level. The importance of monitoring and assessing climate change adaptation policies is also highlighted for the society at large to comprehend the impact of policies and actions. Therefore, one of the purposes of this paper is to inform about the need of urban resilience not only for an improved environment, but also for increasing the quality of life.

2. Key Concepts and Theory

The following chapter presents key concepts and theories which have the role of contouring the context of this research. Hence, several main concepts are defined and discussed for a general understanding of the domain in which urban resilience is built. Afterwards, the necessity of determining a set of indicators based on multiple dimensions for measuring and assessing the success of policies and action plans, i.e. CCASs, is emphasised. These will serve the purpose of identifying best practices within the selected cases.

2.1. Key Concepts

Throughout the last decade, the concept of *urban resilience* has been widely adopted by diverse academics and practitioners. However, there are various definitions of the concept itself as thoroughly illustrated by Meerow, Newell, and Stults (2016). Sanchez, van der Heijden, and Osmond (2018) also acknowledge the various conceptualizations of *urban resilience*. Integrating the 25 definitions presented by Meerow et al. (2016) with other *urban resilience* definitions that emerged from the policy-advising international arena, an overarching one has been developed: “[...] urban resilience can be understood as the ongoing capacity of cities to absorb, adapt, transform and prepare for shocks and stresses along the economic, social, institutional and environmental dimensions, with the aim of maintaining the functions of a city and improving response to future shocks” (Figueiredo et al., 2018, p. 10). The term “shock” is defined as a sudden event (e.g. floods, high winds, droughts, earthquakes etc.) that affects the performance of a system, and the term “stress” refers to a longer term trend that undermines the performances of a system and increases the vulnerability of various areas within it (e.g. natural resource degradation, climate change, political instability, economic decline etc.) (Figueiredo et al., 2018).

Two concepts tightly connected to urban resilience are climate change *mitigation* and *adaptation*. The former is defined by the Intergovernmental Panel on Climate Change (IPCC) (2014, p. 4) as “a human intervention to reduce the sources or enhance the sinks of greenhouse gases”, i.e. climate change *mitigation* consists of actions meant to limit global warming and its related effects. Sanchez et al. (2018) argue that *mitigation* is an important part of resilience-building and emphasise that climate change *mitigation* alongside *adaptation* actions increase climate change resilience.

Salehi et al. (2019, p. 806) define climate change *adaptation* as “the ability of system instability, sustainability, empowerment, productivity, flexibility, and transformation to climate change through the optimal use of resources, resistance, and coping, capacity building

and opportunity creation”. This definition includes the main characteristics of climate adaptation as well as adaptation strategies for climate change.

Adaptation strategies are created by cities that aim to build urban resilience. The strategies highlight where urgent action is needed. Flowing from these adaptation strategies, clear policies can be built as means for effectively and efficiently producing the desired outcomes, for example, reducing the flood risk, making cities more robust to draught, managing the impact of hot weather on the population. Nelson (2010) discusses the relationship between adaptation and resilience, thus the two concepts are interconnected and it is argued that adaptation functions as a means to improve resilience.

Adaptation and urban resilience must be presented alongside the triggers for such need. Thus, cities’ *vulnerability* concept is introduced. Tyler and Moench (2018, p. 318) define vulnerability as occurring “when fragile, inflexible systems and/or marginalised or low-capacity agents are exposed to increased climate hazards, and their ability to respond or to shift strategies is limited by constraining institutions”. In this context, systems are for delivering essential services, complex adaptive systems emphasise the integration of social agents and institutions together with biophysical elements as components of socio-ecological systems, and institutions are represented by “social rules and conventions that structure human behaviour and exchange in social and economic interactions” (Tyler & Moench, 2018, p. 315).

Generally, *public policy* can be defined as “a set of interrelated decisions taken by a political actor or group of actors concerning the selection of goals and the means of achieving them within a specified situation where those decisions should, in principle, be within the power of those actors to achieve” (Howlett & Cashore, p. 18-19). In the context of urban resilience, which can be seen as one goal of environmental policy-making, *public policy* is narrowed down and interpreted as “strengthening the urban system’s capacity to change in response to economic and natural shocks to the system” (Zhao, Chapman, Randal, & Howden-Chapman, 2013, p. 3219). This interpretation of *public policy* can be linked to CCASs’ reason for existence, the necessity of a strong policy to tackle the issues created by climate change through adaptation and mitigation. Nevertheless, taking into consideration how complex the urban systems are, identifying the environmental impacts of urban processes as well as evaluating the efficiency of policies regarding urban resilience is challenging.

2.2. Policy Indicators

The policy-making process involves a wide variety of intertwined elements that are necessary for building realistic policies with achievable objectives. One element that can be argued to be indispensable for good policy is tracking the progress made by applying the policy in question, such as whether all the steps for accomplishing the policy's goals have been taken or whether the targets have been achieved. Consequently, this is an aspect highly relevant for the current research as measuring the CCASs effectiveness is dependent on an appropriate assessment based on well-constructed indicators.

For monitoring and strengthening urban resilience, various papers emphasise the existence of a set of indicators for the relevant policies (Figueiredo et al., 2018; Sharifi & Yamagata, 2016; Ribeiro & Goncalves, 2019). These indicators can be included within the policy-making process for achieving the goal of urban resilience at various governance levels (local, regional, national). Figueiredo et al. (2016) stress the application of these indicators at the local level and their role within the resilience-building process, defining the context of this paper. Figueiredo et al. (2016) also draw attention to the fact that policy objectives should be the ones guiding the development of indicators as these objectives are needed to identify which resilience dimensions should be monitored with indicators. Overall, indicators are meant to function as tools for assessing, informing and monitoring policies as to “create an evidence base from which to build better policies” (Figueiredo et al., 2016, p. 24).

As assessment tools, indicators help identify risks and vulnerabilities, as information tools, they help design and implement various plans (e.g. emergency plans, land-use plans), and as monitoring tools, indicators “can identify how well a city has responded to and recovered from disasters and shocks and whether the targets [of policies] will be met” (Figueiredo et al., 2016, p. 26). Moreover, indicators can aid policy-makers to better design the policies that are needed for improving cities. In the context of London and Vancouver's CCASs and other relevant documents, indicators play a crucial role in understanding the city's resilience-building process and progress. Additionally, the presence of indicators within these documents strengthen the connection between government and communities as they are meant to assess, inform and monitor urban resilience-building in a comprehensible manner for the public.

The indicators presented within the works of Figueiredo et al. (2016), Sharifi and Yamagata (2016), Ribeiro and Goncalves (2019) have been compared and combined, hence the prominent ones are considered to be within the environmental, economic, social, institutional and infrastructure dimensions (see Appendix A).

The environmental dimension refers to the natural environment as well as to the systems and networks set for managing it (Figueiredo et al., 2018). Resources like wetlands “are necessary for absorbing impacts of disasters such as flood and improving the recovery process” (Sharifi & Yamagata, 2016, p. 264). The economic dimension reflects the economic conditions of a city or community. Contributing to economic resilience are reliable infrastructure and skilled labour force (Figueiredo et al., 2018). “Economic resilience of a community depends on the capacity and skilfulness of its working population to support the dependent population” (Sharifi & Yamagata, 2016, p. 266). The social dimension deals with the well-being of a society and its members either organised or not. It is highly relevant for resilient cities to adopt coordinated and coherent economic and social policies and practices as they can aid the cities in addressing change smoothly (Figueiredo et al., 2018). Various literature has paid attention to the social and well-being dimension since it is considered to strongly influence the achievement of community self-sufficiency and resilience (Sharifi & Yamagata, 2016). The institutional dimension is connected with the leadership of cities, such as governments, organized civil societies and private stakeholders. Moreover, through resilient institutions, the policy-making process and the policy implementation can be open, transparent and inclusive (Figueiredo et al., 2018). Also, the institutional dimension, as discussed by Sharifi & Yamagata (2016, p. 268), can be useful for evaluating the “efficiency and effectiveness of relationships between and within community organisations and entities”. Lastly, the infrastructure dimension has redundancy and robustness as key factors. The former facilitates the replacement of infrastructure in the case it becomes faulty, while the latter is concerned with strengthening the infrastructure against shocks. Regular monitoring is needed for ensuring the proper actions are taken when needed for improving the infrastructure, such as retrofit, refurbishment, and technology update (Sharifi & Yamagata, 2016).

Each of the aforementioned dimensions contains a multitude of indicators that can be arbitrarily set by policy-makers. Sharifi and Yamagata (2016) as well as The Rockefeller Foundation and ARUP (2015) feature examples of indicators for each dimension. However, the former provides an extensive list of criteria and indicators, whilst the latter’s list is more compressed. As such, the CCASs to be analysed within this paper, the ones developed for London and Vancouver, are expected to contain a set of indicators in line with the determined dimensions (see *Table 1*).

Table 1. Example of indicators for measuring urban resilience

Dimension	Indicators
Environmental	<ul style="list-style-type: none"> • Hazard exposure and mapping • Protective ecosystems
Economic	<ul style="list-style-type: none"> • Public finances • Integration with regional and global economies
Social	<ul style="list-style-type: none"> • Community support, community cohesion • Engaged citizens • Housing • Sanitation
Institutional	<ul style="list-style-type: none"> • City monitoring and data management • Co-ordination with government bodies
Infrastructure	<ul style="list-style-type: none"> • Transport networks • Maintenance • Infrastructure services

Note. Own elaboration based on information retrieved from The Rockefeller Foundation and ARUP (2015).

All the above-mentioned information is going to play an important role in discussing how urban resilience is built within the two cities selected for a thorough analysis, London and Vancouver. The definitions of urban resilience, vulnerabilities of cities and public policy within the context of climate change help frame the progress of London, respectively Vancouver. Furthermore, the indicators presented are a means for observing the main focus for each of the two cities and monitoring their achievements. Therefore, observing the cities' progress over a decade will allow for a better understanding of how to successfully build urban resilience across the world.

3. Methodology

This chapter discusses the study's methodology, reasoning for approaching the research from a specific perspective. In addition, the methodology allows for a critical evaluation of the

study's reliability and validity. Below, the research design, case selection and data collection methods are elaborated upon.

3.1. Research Design

This paper's research relies on qualitative research aiming at "providing an in-depth and interpreted understanding of the social world" (Snape & Spencer, 2003, p. 3). Patton (2015) emphasises the more personal approach towards making sense of the world in comparison with quantitative research. The goal of the current research, in line with the qualitative research's properties, is to obtain a deep understanding of the impact resilience-building action plans defined within the CCASs can have on London, respectively Vancouver. This is meant to be achieved through a comparative analysis on the issue of adapting and building resilience against floods. As this research consists of descriptive work, aiming at accurately illustrating the current relevance of urban resilience-building through the policy-making perspective, qualitative research is more appropriate than quantitative.

To answer the descriptive research question posed above, this study is conducted as a descriptive longitudinal design. The design is defined as "research emphasising the study of change and containing at minimum three repeated observations (although more than three is better) on at least one of the substantive constructs of interest" (Ployhart & Vandenberg, 2010, p. 97).

The cities of London and Vancouver will be analysed from 2011, respectively 2012, until 2021 using data provided by CCASs and other related documents. This allows for a detailed approach, unlike cross-sectional research that would only offer insight into the variables in question at one particular point in time. The longitudinal research design's advantage lies in how variables might change over time, instead of measuring variables at only one instance. It is useful for describing a phenomenon's development over a certain timeframe and for predicting a variable's future changes. The longitudinal research design requires repeated measurements of the same variable, thus issues arise in cases where the data collection method implies a significant increase in resources required for the realisation of the research (e.g. funds and time for large-scale or field-work based interviews). This paper, however, relies solely on pre-existing data, generated from secondary sources, hence the aforementioned constraint does not apply. For the analysis, a document analysis is needed, thus the text-coding method is employed and completed through the Atlas.ti software.

Qualitative descriptive research faces two threats: reliability and validity (Lewis & Ritchie, 2003). Reliability refers to the replicability or confirmability of the researchers' results with the same or similar methods. Several social scientists argue that qualitative research might not be replicable at all since many types of qualitative data are personal and subjective in nature (Lewis & Ritchie, 2003). Thus, an often encountered argument is that reliability in qualitative research is associated with the ability to confirm previous results rather than replicate them.

3.1.1. Reliability

In terms of reliability, the research presented within this paper is expected to offer similar findings in case of replication of the study. The method through which reliability is checked the easiest involves the use of the codebook on the basis of which the data collected will be coded. Part of the text can be coded and the reliability can be verified by cross-checking for intercoder reliability (Cho, 2008).

3.1.2. Research Validity

Two dimensions are related to the research validity concept: internal and external validity. Internal validity refers to the extent to which a given research studies indeed what is claimed to be studied. Yin (2016) presents multiple methods that can be used for strengthening the internal validity of research, such as the trustworthiness of data and triangulation, converging information from different sources. Within this study, the former method relates to the main data source being represented by official documents, such as London and Vancouver's CCASs, progress reports and other documents focusing on a certain issue caused by climate change. These documents can be argued to contain reliable and valid information as they are issued by the government and other internationally recognised bodies.

Because the documents analysed for the present research are unique and non-academic, triangulation of the data is possible solely by comparing CCASs with progress reports of the CCASs and other documents similar to these that contain necessary information for conducting the overall analysis of London, respectively Vancouver. Furthermore, these documents can increase validity since practices are expected to be measured through a set of indicators, as introduced within Chapter 2. These indicators allow the measuring of CCASs' success in urban resilience-building and, through them, best practices are meant to be distinguished.

External validity refers to the generalization extent – the degree to which results of the study can be applied to different populations, settings or contexts (Lewis & Ritchie, 2003). Since case studies are determined within one specific context, generalizations can create issues unless

carefully designed. Every case study's purpose is to formulate statements or have some sort of statements that are applicable beyond the immediate situation under study (Flick, 2011). The goal is to "discover patterns and processes within the case and to use analytic generalization to extract the lessons learned" (Yin, 2016, p. 105). A typology of case selection techniques is presented by Seawright and Gerring (2008). The following section elaborates on this topic.

3.2. Case Selection

The case selection process comprises four steps: determining the inquiry purpose, focussing the inquiry question, deciding what data to collect and selecting which cases to study (Patton, 2015). Following this process, this study's research purpose is to illuminate a societal need (the need for urban resilience) and the ways in which it can be accomplished across the world. Consequently, the question "*How can leading cities in the field of environmental sustainability become more resilient to climate change?*". This research question is not yet narrowed down, as the cases to be studied are not present. The following discussion leads to the cases' determination.

Building urban resilience to climate change is a prominent subject nowadays. Resilience-building can be accomplished by linking the academic and governmental fields through policy-making. For implementing measures of dealing with the threats of climate change, measures that include climate change adaptation, policy-makers must set steps needed for their population to take action. Thus, policies are necessary to guide the actions of the population at large as well as the actions of powerful actors within various domains. Thence, two networks that spread awareness about climate change threats, shape policies, and take action to adapt and combat the arising issues were identified, the 100 Resilient Cities (100RC) and the C40 Cities Climate Leadership Group (C40) (see Appendix B). Since the 100RC programme has ended in April 2019 and C40 is ongoing, a list of cities that have participated in both 100RC and C40 was obtained. The list was narrowed down to two cities, London, UK, and Vancouver, CA. The choice was further based on the C40 network's membership categories: steering committee, innovator city, megacity and observer city (see Appendix C).

A steering committee city (London, UK) and an innovator city (Vancouver, CA) were selected. Four selection criteria were used: the governments' transparency, the cities' dedication to act against and adapt to climate change, the need to become resilient to floods, and the distinct governance modes. The governments' transparency ensures the public availability of documents. London and Vancouver are both part of the C40 network, thus have the same main goal of striving for becoming resilient. While London faces the threat of tidal, fluvial and

surface water flooding, Vancouver has to combat coastal and surface water flooding. In terms of governance mode, London's local government is divided into two tiers: the upper tier – the Greater London Authority (GLA), controlled by the Mayor of London and the London Assembly, – and the lower tier – 32 borough councils in Greater London, and the London Corporation in the City of London. Vancouver is governed by the 10-member Vancouver City Council, a nine-member School Board, and a seven-member Park Board, all elected for four-year terms. Unlike London, Vancouver does not have a strong mayor system of government.

3.2.1. Generalising from Qualitative Case Studies

Seawright and Gerring (2008) present seven distinct types of case studies, outlining how to effectively infer patterns useful later for checking their generalizability. Based on their definition, the cases selected for this research correspond to the category of a most similar case study. The conditions which a most similar case study has to fulfil are a minimum of two cases and that they present similarities on as many variables as possible except for the variable of interest (Seawright & Gerring, 2008). As the previous sub-section has indicated, the cases chosen, London and Vancouver, are indeed similar in terms of various dimensions relevant for this study.

Later chapters of this paper provide evidence that they do differ when it comes to the dependent variable of interest, the types of action required to adapt and combat the threats presented by floods. This strengthens the cities' as being cases representative for a most similar case study design. A most similar case study research requires the cases to represent the general population from which they were selected. In the present instance, it is expected that the findings will be generalizable to other cities across the world that face similar climate change-triggered issues, have similar resources and governance modes as London, respectively Vancouver.

3.3. Data Collection

The data collection and the subsequent analysis for this paper exclusively follow a qualitative approach, namely a document analysis. The data itself is mainly secondary data gathered by the cities of London and Vancouver in the context of climate change adaptation and resilience-building between the years 2011-2021. Additional information was acquired through other London, respectively Vancouver, documents required for completing the analysis. All these documents were retrieved through searching the databases of the London Government website, respectively the City of Vancouver and Vancouver's City Council websites. Keywords such as "climate change adaptation", "flood", "indicators" were used for identifying the relevant

documents. Furthermore, the documents selected create a network as they complement one another. *Table 2* features the documents' list.

Table 2. List of relevant documents for London and Vancouver

Document type \ City	London, UK	Vancouver, CA
Climate Change Adaptation Strategies	Climate Change Adaptation Strategy (2011)	Climate Change Adaptation Strategy (2012; 2018)
Progress Reports and Updates	London Sustainable Drainage Action Plan (2016)	Rain City Strategy (2019)
	London Environment Strategy (2018)	
Other Documents	London City Resilience Strategy (2020)	Coastal Flood Risk Assessment (2018)
	The London Plan (2021)	Resilient Vancouver (2019)

3.3.1. Climate Change Adaptation Strategies

CCASs are documents produced by governments to inform about and assess the local, regional or national challenges related to climate change that residents face. These strategies also contain action plans for how to combat these challenges. The CCASs analysed are local ones from the cities of London, respectively Vancouver. Overviews of the two CCASs are provided below.

3.3.1.1. London, UK

London has developed its CCAS in 2011 during the mandate of Mayor Boris Johnson. Since then, under the new Mayor, Sadiq Khan, various other strategies (London Environment Strategy, London City Resilience Strategy) also containing action plans for climate change adaptation emerged. These other strategies will be treated as documents containing updated action plans for climate change adaptation and as other documents relevant for obtaining the full image of the threats London must combat.

2011 London Climate Change Adaptation Strategy

London's CCAS provides information about the future climate of London based on observations from previous years, setting up climate predictions: warmer, wetter winters and hotter, drier summers, extreme weather events (e.g. heatwaves and heavy rainfall). The sea levels are expected to rise continuously for centuries to come. Having highlighted the threats, the strategy determines the responsible parties for climate change adaptation and identifies the gaps in enabling adaptation.

The strategy presents a detailed discussion about three main factors long-term affecting London: flooding, drought and overheating. London is vulnerable to flooding from the North Sea (tidal flooding), the freshwater Thames and tributaries to the Thames (fluvial flooding), and from heavy rainfall (surface water flooding). Droughts threaten the sustainable withdrawing of water from the environment, the security of the water supply. Overheating can affect the health and comfort of Londoners as well as the city's infrastructure. London is more vulnerable than other UK cities since the capital is located in the warmest part of the UK. Poor air quality contributes to higher temperatures, too.

The impacts of the aforementioned factors on cross-cutting issues within London, such as health, economy, environment and infrastructure are assessed. Response measures are set, the assessment and implementation of action plans to work towards climate change adaptation being done by the government of London alongside stakeholders.

London's CCAS features a list of actions plans for climate change adaptation. Additional information about the leaders as well as the stakeholders involved in each action plan is given. Deadlines have been determined for implementing these plans.

3.3.1.2. Vancouver, CA

Vancouver has published its first CCAS in 2012. Since then, it has also developed other strategies (Resilient Vancouver, Rain City Strategy) and provided an updated CCAS in 2018. An overview of both the 2012 and 2018 CCASs follows.

2012 Vancouver Climate Change Adaptation Strategy

Vancouver's 2012 CCAS informs about what adaptation means and the methods used for developing the strategy itself. Impacts on the city of Vancouver have been identified and prioritised through risk and vulnerability assessments. Hence, adaptation actions have been devised in accordance with priorities.

The regional and local climate change threats are identified and discussed. The most concerning threat is the temperature increase, thus affecting the mountain reservoirs water supply. Additionally, the portion of the Fraser River contiguous with Vancouver is tidally dominated, climate change impacting the water availability and habitat. The risk of floods is also increased. Extreme weather events and their consequences are mapped out for producing reliable action plans. Treated separately is the rise of the sea level, a direct impact of global warming – warmer weather triggers the melting of glaciers and ice caps and the thermal expansion of oceans. Therefore, Vancouver is vulnerable to surface water flooding caused by precipitations and coastal flooding from the Fraser River.

The 2012 strategy focuses on impacts on infrastructure, human health and welfare, environment, economy and the coastal zone. Action plans for each of these areas are devised and presented within the strategy, plans that are meant to be updated and revised every five years unless emergency events cause the need for earlier revisions. Annual evaluations are also planned for evaluating the strategy and staying current with climate science.

The 2012 strategy has been successful in implementing over 50 action plans across Vancouver which have increased the city's preparedness for climate change. The achievements of this first strategy include the internationally recognized Coastal Flood Risk Assessment (CFRA), changes in the design and approach of drainage.

2018 Vancouver Climate Change Adaptation Strategy

The 2018 CCAS of Vancouver features a new set of priorities, supporting actions and several new focus areas. Part of these new focus areas are the better integration of the strategy with other city work via co-benefits and earlier identification of overlap while also striving for equity. The action plans are split into core actions (84) and enabling actions (17), hence swifter preparations and implementation can be accomplished. The strategy and other existing city and community strategies (Resilient Vancouver Strategy, Rain City Strategy) and efforts are complementary, their aim being to improve the overall resilience of Vancouver to shocks (e.g. earthquakes, floods and extreme weather) and climate-related stresses (e.g. hotter, drier summers and sea level rise).

Similar to the 2012 strategy, the 2018 one presents an overview of the climate change threats Vancouver faces focusing on three points: hotter, drier summer, warmer, wetter winters, and sea level rise. The impact areas are the human systems (community), natural systems, and built environment (buildings and infrastructure). The 2018 strategy continues the climate adaptation

through multiple enabling actions divided into four areas: mainstream effectively, improve data and information, build capacity and knowledge, and strong leadership, partnership, governance. There are five core action categories: climate robust infrastructure, climate-resilient buildings, healthy and vigorous natural areas and green spaces, connected and prepared communities, and coastline preparedness. The enabling and core actions must be worked on in parallel to support a more integrated, system-wide approach for obtaining a more innovative city-building and transformational adaptation.

Each of the core actions has a set of objectives that are meant to be accomplished through a matching set of priority actions. The action plans needed to be done for achieving the goals are listed within the strategy together with indicators for building a program that over time ensures the actions taken are making Vancouver more climate-resilient.

3.3.2. Progress reports and updates

3.3.2.1. London, UK

For London, there is no progress report on the 2011 CCAS since no data was collected to monitor and assess how well the city is adapting to the impacts of severe weather and climate change. Thus, there is no indication whether the efforts for reducing risks and increasing resilience are working (GLA, 2018, p. 354). However, other documents, such as the 2016 London Sustainable Drainage Action Plan and the 2018 London Environment Strategy, can be used for observing new policies and action plans regarding flood adaptation.

2016 London Sustainable Drainage Action Plan

The 2016 London Sustainable Drainage Action Plan's (LSDAP) scope is adapting to the flooding risk. London's population, the changing land uses as well as the changing climate face an increased flooding risk which the Victorian drains and sewers cannot combat. As such, multiple action plans were set for improving London's Victorian drainage system to work more naturally, thus bringing about a wide range of benefits, e.g. steadily influencing flood risks by easing the burden on drains and sewers, reducing pollution of the tributary rivers and streams. The main objective of the LSDAP is the retrofitting of sustainable drainage to existing buildings, land and infrastructure.

LSDAP complements other documents and strategies, such as the London Environment Strategy and the London Plan. The progress made until February 2021 has been recorded. Many areas have shown promising results (the London Plan, education, transport, health sector), whilst work in other areas has not yet commenced and is programmed for the near

future (retail sector, public sector buildings, industrial and major utilities, agriculture). There are several areas in which the work continues, but the Coronavirus pandemic has halted the progress of (recreational land/other open space, commercial offices).

2018 London Environment Strategy

The purpose of the 2018 London Environment Strategy is to ensure a greener, cleaner and ready for the future London. Therefore, the Strategy brings together approaches to every aspect of London's environment, integrating the following areas: air quality, green infrastructure, climate change mitigation and energy, waste, adapting to climate change, ambient noise, and low carbon circular economy.

Within the climate change adaption chapter, the Strategy emphasises the increased flooding risk, especially surface water flooding. London is partly protected from tidal flooding by the Thames Barrier, tidal walls and embankments. However, the standards of protection in the western Thames and its tributaries are lower. A fifth of London is in the Thames floodplain, this area being well-defended by hard-engineered flood defences, yet these can offer protection only from predictable fluvial and tidal flood risk. London is vulnerable to less predictable surface water and sewer flooding caused by heavy rainfall and the existence of impermeable surfacing (roads, roofs, pavements). Policies and policy proposals are set for flood prevention and management.

Accompanying the London Environment Strategy is an annual progress report, the latest being from December 2019. Regarding the green infrastructure for flood prevention area, the Mayor has done considerable efforts, such as joining in on climate change adaptation and mitigation actions, funding more green spaces across London better for holding and slowing down rainwater, therefore reducing surface water flooding, setting in motion the LSDAP, and working together with partners and stakeholders for further improving London's chances to adapt to climate change and build resilience.

3.3.2.2. Vancouver, CA

2019 Rain City Strategy

The 2019 Rain City Strategy has a pivotal role in flooding risk mitigation, therefore further setting the context of climate change adaptation. The Rain City Strategy is part of the green rainwater infrastructure planning process. The goal of the Strategy is to transform and reimagine the rainwater management within Vancouver, having the objectives of improving water quality, resilience, and livability through creating healthy urban ecosystems. Moreover,

the Strategy aims to implement sustainable water management in the scope of using rainwater as a resource rather than a waste product. This plan also aids Vancouver's economy as it is a cost-saving investment. The Rain City Strategy is currently underway, with several action plans already being implemented.

3.3.3. Other documents

3.3.3.1. London, UK

2020 London City Resilience Strategy

The 2020 London City Resilience Strategy aims to ensure the UK capital will remain resilient and prepared for future challenges. The Strategy highlights potential threats to London's safety and stability and emphasises stresses that are likely to affect the city's future success. Furthermore, challenges, as well as mitigation activities, are addressed to ensure London will thrive even when it faces disruption. Projects promoting a collaborative approach to mitigating future challenges are set out within the strategy. These challenges include impacts of climate change and extreme weather events on the urban environment. Additionally, the projects support London's communities, governance and data-led approach to resilience-building. Several of the listed actions are specifically meant for water systems and infrastructure, hence the prevention of floods is a priority of London's government.

2021 London Plan

The 2021 London Plan is the Spatial Development Strategy of London, setting out a framework for how the capital will develop over the next 20-25 years. The Plan is part of the statutory development plan for London, policies being meant to inform decisions on planning applications across London. As such, the Borough's Local Plans must generally conform with the London Plan so that London's planning system is embedded in collaboration and cooperation reflecting the overall strategy for the sustainable development of London.

Regarding the flooding risk and management, the London Plan proceeds to devise several policies that tie in with actions for protecting London against floods. The majority of the policies that tackle the flooding problem is under the Sustainable Infrastructure focus area. One specific policy (Policy SI 12 Flood risk management) provides detailed planning of the actions and actors involved in the achievement of adaptation and mitigation against floods.

3.3.3.2. Vancouver, CA

2018 Coastal Flood Risk Assessment

Vancouver's CFRA project has identified the city's vulnerabilities to coastal flooding and provided approaches and timelines for implementing adaptation measures. The CFRA has three phases and is now ready to be implemented. Phase I confirms Vancouver's high vulnerability to floods caused by the mixed effect of coastal storms and king tides (high tides typically occurring in December and January) and lower vulnerability to river-related floods caused by spring run-off. Phase II emphasises Vancouver's need of flood protections since park spaces, industrial land, critical infrastructure and a high number of residents can be affected by floods. The approaches that Vancouver takes for providing the required protection emphasise cost-effectiveness, adaptability over time, and co-benefits. Phase III provides the Sea Level Rise Planning Framework for prioritizing flood management planning and implementation across the city in line with the outputs of Phase I and II. Furthermore, Phase III guides Vancouver's monitoring of sea levels and integration of updates sea level rise information into land-use and infrastructure decisions. The tools within the latest phase are going to aid the future implementation of coastal flood protection.

2019 Resilient Vancouver

The 2019 Resilient Vancouver strategy has been developed in accordance with the values and help of the 100RC. The strategy has three priority areas (thriving and prepared neighbourhoods, proactive and collaborative city, safe and adaptive buildings and infrastructure), each with four main objectives. Multiple of these objectives have goals to gather more necessary information about the flooding risk and developing drainage, sewer and flood management systems and infrastructure for adapting to this risk.

4. Analysis

The following analysis is divided into two major parts: firstly, the cases are analysed individually based on the data obtained from publicly available documents pertaining to the London, respectively Vancouver, governments. Secondly, a comparative analysis will be conducted. The analyses are realised with the aid of a codebook designed for the purpose of this thesis (see Appendix D). The coding was done in three rounds, thus the analysis will be as such: a discussion of the general policies, proposals, recommendations and action plans, followed by the main methods of addressing climate change as well as vulnerabilities, and finishing with the dimensions covered by the policies.

4.1. Case-Specific Analyses

4.1.1. London, UK

Within the documents selected, the flood risk is acknowledged by the Mayor of London and other governmental bodies, thus a number of policies, proposals, recommendations, and action plans for managing the flood risk within the city are presented. The majority of the policies and action plans featured within most documents are to be designed and implemented through the cooperation and collaboration of London's government with other actors, for example, the public and private sectors (GLA, 2011; GLA, 2016; GLA, 2020). The policies generally cover a multitude of sectors that are vulnerable to floods, areas considered vulnerable on the basis of data and observations gathered by the London government as well as by its partners (e.g. London Climate Change Partnership, the Environment Agency). The sectors identified as being the most threatened by the flood risk are infrastructure, healthcare, transport, business, and housing (GLA, 2011; GLA, 2016; GLA, 2020). The goal of all policies, proposals, recommendations, and action plans is to enhance the adaptability and resilience of London as a city to the tidal, fluvial, and surface water flood risk (GLA, 2011; GLA, 2016; GLA, 2018; GLA, 2020; GLA, 2021).

Within the CCAS, the policies and actions proposed for flood-risk management are meant as a means for increasing London's resilience. Generally, the policies and action plans aim to provide the public with the necessary information for being aware of and understanding the flood risk, methods for how the public can prepare for floods as well as information about the plans the government has for helping the population prepare and recover from floods (GLA, 2011).

Stemming from the policies and actions plans of the 2011 CCAS and the 2016 London Plan (now replaced by the 2021 London Plan), the 2016 London Sustainable Drainage Action Plan (LSDAP) focuses primarily on managing the surface water flood risk together with the sewerage overflow risk (GLA, 2016). Within the document, direct connections with previously set policies (e.g. 2016 London Plan Policy 5:13 Sustainable Drainage Planning) are made and the newly designed actions have as scope the improvement of London's drainage and sewerage system, so that they are capable of dealing with the scale of the flood risk (GLA, 2016). The LSDAP puts together a list of action plans for each area vulnerable to surface water flooding (e.g. transport, housing, retail/commercial, education, healthcare etc.), thus ensuring that

recommendations and action plans for sustainable drainage meant to build resilience are brought to the London public.

Unlike previous documents, the 2018 London Environment Strategy (LES) provides better insight into what London's government and its community need to do to become more resilient to the flood risk. The policies presented within the LES build-up on previously set policies, particularly several policies functioning as follow-ups to the recommendations and actions featured in the 2016 LSDAP (GLA, 2018). The 2020 London City Resilience Strategy (LCRS) briefly focuses on managing the flood risk. The 2021 London Plan (LP), although it has few policies and proposals that cover the flood risk, developed a single policy containing several proposals solely dedicated to managing the flood risk.

It can be argued that the mentioned documents are complementary, especially the documents published in 2018 and after. For instance, the policies and action plans featured in the 2020 LCRS complement the ones present in the 2018 LES, whilst the 2021 LP is linked to the 2016 LSDAP through a policy specifically addressing sustainable drainage.

In all documents, adaptation and resilience-building policies are present more often than policies meant for mitigating the flood risk or identifying vulnerabilities. Considering that the general goal is for London to adapt and become more resilient to the flood risk, the heavy presence of adaptation and resilience policies can be argued to be the proper approach for achieving this goal.

The adaptation measures propose further development of policies, regulations, action plans to continuously provide flood protection to the city and its residents. As such, thresholds for identifying the moment when local efforts are no longer sufficient must be set so that aid can be requested from regional and national levels (GLA, 2011). Policies focusing on resilience tend to aim at strengthening the already existing flood defences and further informing the community about what the government is doing to ensure the city's ability to resist, respectively recover, from various types of floods. The policies that aim for mitigating the flood risk are generally related to reducing the fluvial and surface water flood risk mainly by re-directing the run-off to the river or within a designated floodplain area (GLA, 2011; GLA, 2016; GLA, 2018; GLA, 2020). These policies' objectives can be achieved by firstly identifying the vulnerable areas of London that need to be secured, hence several policies for observing vulnerabilities emerged (GLA, 2018).

Adaptation, resilience, mitigation, and vulnerability policies are part of five dimensions: environmental, economic, social, institutional, and infrastructure. It was observed that the majority of policies from all four previously mentioned domains are part of the infrastructure and institutional dimensions. The environmental and economic dimensions contain several policy proposals and recommendations. However, the social dimension remains one that has few policies prior to 2018 and afterwards none.

The infrastructure dimension encompasses policies, proposals, and action plans that aim to improve the existing infrastructure assets. This leads to further adaptation to the flood risk caused by climate change as well as to increasing London's resilience against floods. Several documents present policies and action plans for upgrading infrastructures, such as drainage and sewerage systems, as to increase its capacity for water flow, while also working towards developing new flood defences (GLA, 2016; GLA, 2018; GLA, 2021). For example, the Thames Tideway Tunnel project is meant to "prevent all but the most severe sewer overflows into the Thames" (GLA, 2016, p. 5). Furthermore, developing sustainable drainage techniques, a hierarchy of broad drainage methods, will allow for re-directing overflow water that can be used for other purposes (GLA, 2016; GLA, 2021). There are also proposals for strategically placing green infrastructure (e.g. vegetation) to further stabilize the land and adapt to the flood risk (GLA, 2011; GLA, 2018). Other infrastructure improvements for transport and business are crucial for increasing London's resilience (GLA, 2016; GLA, 2020; GLA 2021).

The policies within the institutional dimension focus on decisions needed to be taken at the local government level and between actors for gathering new information about plans aimed at resilience-building within flood-vulnerable London areas. There are also policies for developing channels for raising awareness about the flood risk (GLA, 2011). Recommendations and proposals meant to create new standards and plans as to further maintain the proper functioning of the infrastructure are also taken into account (e.g. drains, sewers) (GLA, 2016). Similarly, the 2018 LES, 2020 LRCS, and 2021 LP offer updated and new policies for resilience-building.

The economic, environmental, and social dimensions are much less prominent than the other two. The economic dimension features policies dealing with clean-up costs and loss of businesses revenue post-flood (GLA, 2011; GLA, 2018), recommendations for various flood prevention and reduction projects' budgets (GLA, 2016) and for improving the infrastructure so that businesses will continue prospering in the aftermath of floods (GLA, 2021), and cost-effectiveness water catchment strategies (GLA, 2021).

Few policies within the environmental dimension exist, yet they are meant to reduce the environment's vulnerability to floods (GLA, 2011; GLA, 2018; GLA, 2021). Similarly, the social dimension encompasses few policies too. In the 2011 CCAS, social dimension policies are introduced, however, in later documents, there is little to no indication of the dimension. The present policies focus on improving the communication channels as to engage the community in adapting and becoming resilient to the flood risk (GLA, 2011).

Overall, the policies within the infrastructure and institutional dimensions pave the path towards London building resilience. These can be argued to be the strongest dimensions for resilience-building as the institutional policies aid the process by setting the basis, while the infrastructure policies deliver concrete action plans to be implemented. The gap existing within the economic, environmental, and social dimensions can be seen as slowing the resilience-building process. For instance, regarding the social dimension, raising awareness is the first step towards involving the community within the process, however, the lack of indications as to what individuals can do to increase their homes' resilience can result in wide-spread residential areas vulnerable to the flood risk. Similarly, the scarce economic and environmental dimension policies may falsely underestimate the scale of the flood risk by overlooking vulnerabilities. Therefore, London's government and decision-making bodies need to broaden their views as to how to make the resilience-building process more efficient and effective.

4.1.2. Vancouver, CA

Within the selected documents, policies and action plans are set as to manage within Vancouver the flood risk emerging from various sources (mainly coastal and surface water). Several sectors have been identified as flood-vulnerable, such as infrastructure, healthcare, community, business, and transport (City of Vancouver, 2012). Throughout the documents, the main goal is for Vancouver to be able to adapt and build resilience against the flood risk. Thus, objectives and accompanying action plans were developed over the decade as to guide the process towards reaching this goal. Vancouver's government often acknowledges that it must be directly involved in the development and implementation of action plans alongside various actors for resilience-building (City of Vancouver, 2012; City of Vancouver, 2018). The 2012 CCAS proposed a variety of action plans as a means for managing the flood risk and building resilience.

The 2018 CCAS builds upon the previously set policies and plans (City of Vancouver, 2018-a). Five core action priorities are featured within the latest CCAS, several addressing recommendations for managing the flood risk. The government provides guidance for the

community so they can be involved in the resilience-building process. Actions for managing the flood risk by taking into consideration a number of areas in which efforts can be put are an important method of raising awareness about the risk (City of Vancouver, 2018).

The 2019 Rain City Strategy aims for Vancouver to become a water sensitive city (to include the urban water cycle into urban design as to minimize environmental degradation) (City of Vancouver, 2019). Through actions meant to achieve this goal, Vancouver simultaneously works towards reducing the flood risk for various sectors, although mainly on infrastructure.

The 2018 Coastal Flood Risk Assessment (CFRA) partly presents recommendations and proposals that can aid Vancouver to become resilient to the flood risk. The document focuses primarily on the flood risk related to sea level rise, i.e. coastal flood. The recommendations come from the General Manager of the Planning, Urban Design and Sustainability department and are addressed to the Standing Committee on Policy and Strategic Priorities. As such, they are simply designed recommendations that may be transformed into public policy. At the moment of the analysis, the last CFRA report is not published.

The 2019 Resilient Vancouver strategy has multiple objectives for building resilience from which a few are meant for managing the flood risk, both coastal and surface water flooding. The action plans featured within this strategy are considerably more complex compared with those from the first CCAS.

All these documents are complementary, as each new published one focuses on various methods of improving resilience. For instance, the 2018 CCAS further proposed action plans in continuation of the ones within the 2012 CCAS, and the 2019 Rain City Strategy actions are built upon and continuing the efforts the 2018 CCAS started.

Throughout the documents, the majority of policies for managing the flood risk address climate change through adaptation and resilience. Few policies, recommendations, and action plans focus on mitigation and identifying vulnerabilities (City of Vancouver, 2018-a; City of Vancouver, 2018-b; City of Vancouver, 2019-a). There are instances where measures such as adaptation and resilience overlap and documents published more recently have fewer mitigation measures than earlier documents.

Adaptation measures involve further development and new proposals for improving Vancouver's resilience, while resilience actions are focused on strengthening the existing flood-vulnerable services and assets. Mitigation measures are mainly oriented towards upgrading and improving the existing infrastructure systems for combating the flood risk.

These measures can be properly implemented once vulnerable areas are identified, thus recommendations are made for further studies to observe vulnerabilities (City of Vancouver, 2018-b).

Adaptation, resilience, mitigation, and vulnerability policies are part of five dimensions: environmental, economic, social, institutional, and infrastructure. It was observed that the majority of policies from all five previously mentioned domains are part of the infrastructure and institutional dimensions. The environmental and economic dimensions contain several policy proposals and recommendations. However, the social dimension remains one that encompasses few policies throughout the decade.

The infrastructure dimension contains policies that aim at increasing Vancouver's infrastructure resilience and adapting to the flood risk through coastline defences. The infrastructure improvement varies from maintaining and upgrading the existing drain and sewerage systems to identifying and prioritizing the infrastructure for backup power (City of Vancouver, 2012). Also, regular checks and inspections for ensuring that buildings are robust across a range of climate scenarios are proposed to be conducted (City of Vancouver, 2018-a). Within this dimension, policies that encourage the use of green infrastructure for managing the flood risk are present (City of Vancouver, 2012; City of Vancouver, 2018-b). Therefore, the majority of policies within the infrastructure dimension are concerned with building resilience in Vancouver through thorough improvements to various types of infrastructure, goals latest featured in the 2019 Resilient Vancouver strategy (City of Vancouver, 2019-b).

The institutional dimension encompasses policies mainly focused on decisions that need to be taken by the government of Vancouver together with relevant actors for further adapting to the flood risk and building resilience. Thus, more information has to be gathered for understanding the extent to which Vancouver is vulnerable to the flood risk and for seeing which actions must be designed and implemented. Additionally, policies, recommendations, and support for continuously keeping the public informed and involved within the process of building resilience are a constant need (City of Vancouver, 2018-a; City of Vancouver, 2019-a; City of Vancouver, 2019-b). The government is responsible for monitoring and assessing the extent to which policies, recommendations, and actions are successful, so there is always the need of updating the list of indicators (City of Vancouver, 2018-a).

The economic, environmental, and social dimensions are much less prominent than the other two. The economic dimension includes policies for cost-effective adaptation, mitigation and

resilience measures (e.g. comparing the costs of mobile generators with those built into facilities, insurance budgets etc.) (City of Vancouver, 2012), and monitoring the finances for infrastructure and supply chains (City of Vancouver, 2018-b). Hence, the general policies within the economic dimension are related to infrastructure.

The environmental dimension policies and actions are for protecting the environment from the flood risk and for also building the environment's resilience (City of Vancouver, 2012). For instance, reducing the flood risk is a crucial step that needs to be taken as sea level rise will affect the intertidal habitat for wildlife. The habitat is under threat of being "impacted, reduced and squeezed" (City of Vancouver, 2018-b, p. 7).

The social dimension is not so prominent, yet each document presents policies, recommendations and action plans that encourage the engagement of the community to adopt measures that will ensure their homes and surroundings resilience against the flood risk. Communication channels like competitions to raise awareness and support for the design and implementation of flood management techniques are a step towards achieving adaptation and resilience (City of Vancouver, 2018-a; City of Vancouver, 2019-b).

Overall, the policies within the infrastructure and institutional dimensions are the most impactful for resilience-building in Vancouver. The institutional dimension policies function as the basis on which other policies and action plans will be built, while the infrastructure dimension policies set action plans to be implemented. Although there are few policies belonging to the economic, environmental, and social dimensions, they provide the necessary information and plans for resilience-building, therefore the efforts for building resilience across a variety of sectors and areas are evenly spread. Moreover, the majority of the selected documents contain policies for each dimension, hence most vulnerabilities are acknowledged. Having a list of indicators can be argued to aid Vancouver in keeping track of its actions and to identify where more and urgent action is needed.

4.2. Cross-Case Analysis

London and Vancouver are quite similar in the way their governments make use of policies as to shape the action plans for managing the flood risk, thus adapting to climate change and building resilience. Both cities rely on cooperation and collaboration as a means to effectively and efficiently design and implement policies and action plans. Throughout the decade, London and Vancouver maintained their standard of continuously working towards achieving resilience by engaging not only with public bodies, but also with their communities.

The cities are also similar in how they choose to address climate change through the context of managing the flood risk (London – tidal, fluvial, and surface water flooding; Vancouver – coastal and surface water flooding). Identifying vulnerabilities is the first step towards accomplishing their policies' objectives. This step enables the governments to develop the proper measures relevant for the flood-vulnerable areas. As such, adaptation, mitigation, and resilience measures are taken and they are reflected in the policies, proposals, recommendations, and action plans featured within official documents.

In both cities, the selected documents are mainly focused on adaptation and resilience policies. However, it was observed that within early documents, such as the 2011 London CCAS, 2012 Vancouver CCAS and 2016 LSDAP, mitigation policies were also prominent. In later years, the focus shifted solely on adaptation and resilience policies, though. Therefore, London and Vancouver prioritized the efforts for building resilience through adaptation and recovery measures rather than mitigation ones.

As for the dimensions which describe the five resilience drivers, the main ones are seen to be the infrastructure and institutional dimensions. Throughout the years, both London and Vancouver maintained the focus of their policies on designing and implementing various forms of infrastructure (e.g. drainage and sewerage systems, buildings, roads etc.), thus ensuring full coverage and security action plans for flood-vulnerable areas and sectors (e.g. healthcare, housing, education etc.). Continuous efforts of the governments and relevant actors will lead to more policies, recommendations, and action plans meant for improving the resilience of London, respectively Vancouver, as illustrated within the latest documents – the 2021 London Plan, and the 2019 Resilient Vancouver Strategy.

The economic, environmental, and social dimensions are also present within documents, however, policies pertaining to these dimensions are scarce. Thus, the major difference between the two leading cities is featured on the basis of these policies. Additional differences can be observed in the policies that are part of the infrastructure, respectively institutional dimension.

Although both cities strive to use green infrastructure as a means of managing the flood risk caused by climate change, for London, the infrastructure dimension is concerned mainly with upgrading the existing drain and sewer infrastructure and developing new sustainable drainage techniques. The policies focused on infrastructure within London pay attention thoroughly to the drainage and sewerage systems which are meant for mainly reducing the surface water

flood risk. Additionally, London is aware of the need of a new Thames Barrier in the near future (infrastructure implemented for flood protection), therefore part of the government's efforts goes into designing plans on how to cope with this issue. Vancouver also designed and implemented most policies as part of the infrastructure dimension. In comparison to London, however, Vancouver solely took action for improving the existing drainage system, but set other actions for strengthening other infrastructures, such as buildings and roads. Vancouver seeks to build resilience across multiple sectors, simultaneously.

Regarding the institutional dimension, London and Vancouver, are mostly similar. Yet, the major difference is that Vancouver has a set of indicators features within the latest CCAS, so it can measure the extent to which building resilience is successful, whilst London lacks them. As such, besides the institutional dimension policies concerning the development of new policies, plans and projects for increasing the city's resilience, London has to also focus on developing a list of indicators for measuring resilience-building.

Although both London and Vancouver aim to find cost-effective ways of adapting and building resilience against the flood risk, London briefly focuses in few documents on cost-effectiveness in the context of the costs that will be needed to recover from a flood scenario. Vancouver, though also scarcely focuses on economic dimension policies, sets out within each document policies relevant for this dimension, such as planning budgets for resilience-building projects, ensuring business continuity in the aftermath of a flood. Also, the city searches for cost-effective methods to build resilience.

Vancouver is concerned with the flood-protection of the natural environment more than London. The former presents within various documents, such as in the 2018 CFRA, its concern over tidal flooding and sea level rise having a negative impact on wildlife habitat. The latter lacks the environmental dimension within several documents and within early ones' sets policies concerned with protecting the green infrastructure.

As for the social dimension, Vancouver put forth multiple policies that have as scope the engagement of the population with resilience-building actions as to increase the resilience of the community as a whole. In comparison, London has mentioned engaging the community briefly in the 2011 CCAS, however, since then, few proposals and recommendations have been made for direct community engagement. Nevertheless, London continues to raise awareness about the flood risk and to develop the necessary means of communication as to inform the people in case flooding occurs.

Overall, London's policies heavily focus on the infrastructure and institutional dimensions for upgrading and developing new infrastructure for managing the flood risk. As a consequence, the other dimensions, economic, environmental, and social are less covered by policies, therefore gaps are created within the resilience-building process. The lack of a set of indicators for monitoring and assessing the process can be argued to be one of the reasons why London's policies for resilience are unbalanced. The government has acknowledged this issue and is currently preparing indicators as to properly evaluate the progress that has been done so far. Thus, although London has strived for improving the city's resilience against the flood risk and completed as well as implemented various action plans for attaining this goal, there is more to be done before the city can call itself flood-resilient.

Although Vancouver, like London, focuses its policies on the infrastructure and institutional dimensions by maintaining and upgrading its infrastructure to manage the flood risk, the city recognises the importance of all five dimensions. As such, throughout the decade, policies from the economic, environmental, and social dimensions have been designed and implemented for resilience-building. Furthermore, considering that since the 2012 CCAS Vancouver has had a set of indicators to help monitor and assess the resilience-building process, the city has managed to directly identify the areas which needed actions to be taken. Thus, Vancouver has improved its resilience across a variety of sectors and is continuously working to maintain and further increase resilience.

5. Conclusion

This thesis aims to answer the research question "*How can leading cities in the field of environmental sustainability, such as London and Vancouver, become more resilient to climate change?*". In the attempt to answer it, official papers such as climate change adaptation strategies, resilience strategies and other related documents on London and Vancouver were analysed as to observe how the need of urban resilience against the flood risk caused by climate change impacts the policy-making scene within these two cities. While both cities developed policies for addressing the flood risk through adaptation, mitigation, and resilience, and presented policies pertaining to all five dimensions acting as resilience drivers, the methods through which London and Vancouver planned to adapt and build resilience, so far and for the future, are quite different.

The sub-questions to assist in answering the main research question were:

- To what extent does the need of climate change adaptation shape the policies for London, respectively Vancouver?
- What are the indispensable elements climate change adaptation strategies must have?
- What are the common limitations to climate change adaptation strategies?

To answer the first one, both cities developed policies, proposals, recommendations, and action plans across all discussed dimensions, as such, it can be argued that climate change adaptation plays an extensive role in the shaping of policies. Considering that all major documents, such as the CCASs, the 2018 London Environment Strategy and 2021 London Plan, as well as the 2019 Resilient Vancouver Strategy, feature policies having as purpose the management of the flood risk, the policy landscape is heavily influenced by the need of resilience-building through government and other important actors' engagement, including the community.

The second and third sub-questions are answered through the previous analysis chapter. The CCASs' policies and action plans proposed within them have been taken up and implemented throughout the course of a decade. Other policies and plans that have stemmed from the original CCAS and were introduced in several other documents enrich the resilience-building process, as they set out not only adaptation and resilience-building measures, but also aimed to inform and raise awareness about the flood risk problem. The five dimensions, the resilience drivers, are the core of the strategies as they can be used for analysing the extent to which the cities plan to build resilience. The rest of the documents seldom feature all dimensions, nonetheless, they are still highly relevant.

However, there are limitations to London and Vancouver's CCASs: the lack of a set of indicators within the former and the lack of a publicly available progress report of the resilience-building process based on existing indicators within the latter. The policies covering all five resilience drivers function as proxies for evaluating resilience-building. The dimensions allow for a broad comprehension of which areas need further resilience-building actions and they offer an overview of the areas the London and Vancouver governments consider to be priorities for resilience-building. Hence, through this research, the crucial role policy indicators have within measuring the extent to which the cities survive the impact of climate change is emphasised. The dimensions can stand on their own and provide a general indication of the strategies' success on resilience-building, however, the policy indicators are the ones needed for appropriately determining the extent to which resilience is spread across the cities. For now, the indicators determined within Chapter 2 are enough, however, in the future, more research needs to be done on whether additional indicators will be required.

According to the theoretical discussion within Chapter 2, policy indicators would be the most appropriate measurement method for deeming the CCASs successful or not. As such, the major limitations for successful CCASs are as follows. For London, determining the success of its 2011 CCAS is difficult to measure because there is a lack of an indicator list that would make possible the proper evaluation of the policies within the strategy. For Vancouver, although a list of indicators exists within both the 2012 and 2018 CCASs, there is no publicly available data that would allow the evaluation of their success.

Finally, to answer the central research question, both London and Vancouver, as leading cities within the environmental sustainability field, aim to become urban resilient through designing and implementing policies that primarily focus on upgrading and developing their existing infrastructure (e.g. drains, buildings, roads) for managing the flood risk. Additionally, the cities also view as crucial the creation of new policies and action plans for further raising awareness of the flood risk and to continue bringing together relevant stakeholders for identifying the best next course of action.

5.1. Limitations of the study

There are no direct progress reports on the CCASs of London and Vancouver. As such, documents that have emerged from the proposed actions featured in the CCASs are considered indicating the progress towards resilience-building, meaning that there might be actions that have been taken, but not noted. The lack of a final report for Vancouver's CFRA means that there is a possibility the recommendations featured within the latest report are not going to be fully adopted, thus policy dimensions might be left out. Therefore, the analysis of Vancouver would be less accurate. Furthermore, the document analysis has been conducted by a single person, thus it might be the case of cognitive bias within the analysis itself.

5.2. Opportunities for further research

This thesis offers a descriptive insight into the policies designed and implemented by the London and Vancouver governments in their endeavour to increase their cities' resilience. Although the resilience-building process is ongoing, further research could show how effective the implemented action plans and measures have been so far. Moreover, by gathering qualitative data from interviews with, for instance, policymakers, experts or community members, another method of determining the success of CCASs can be developed. Beyond the cities of London and Vancouver, studies can be conducted as to observe how cities around the world build resilience together and how leaders, can influence the resilience-building process of cities facing similar threats and having similar resources.

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Appendix A: Literature list featuring policy dimensions and indicators

Dimensions	Article	Notes	
<ol style="list-style-type: none"> 1. Economic 2. Social 3. Institutional 4. Environmental 	Figueiredo, Honiden & Schumann (2018)	<p>Indicators as part of the policy-making process (informing policy-makers, providing info on the implementation and performance of policies).</p> <p>Indicators of each dimension, although not explicitly stated which are those specific indicators</p>	<p>Indicators</p> <p>Baseline = measurements of demographic characteristics</p> <p>Policy indicators = measure performance of policies along different dimensions (4 categories: input, output, outcome and process indicators)</p> <p>Direct and indirect indicators</p>
<ol style="list-style-type: none"> 1. Materials and Environmental Resources 2. Society and Well-Being 3. Economy 4. Built Environment and Infrastructure 	Sharifi & Yamagata (2016)	<p>Various criteria (indicators) useful for measuring urban resilience brought together for creating an urban resilience assessment tool</p> <p>Helpful as well for creating assessment frameworks for urban resilience</p> <p>Quite a long list of indicators, some relating/overlapping with indicators from the previously mentioned texts, some other indicators being new</p>	<p>Indicators/criteria</p> <p><i>Materials and Environmental Resources</i> e.g. availability and accessibility of resources (air, energy, water, food, soil, etc.) etc.</p> <p><i>Society and Well-Being</i> Assets: e.g. equity and diversity, socio-economic characteristics etc.</p> <p><i>Economy</i> Assets: e.g. structure, dynamism etc.</p>

		<p>Several dimensions consist of criteria related to assets – for thesis more helpful, in my opinion, to focus on assets</p> <p>Easy to follow and understand indicators as they are features in Tables</p>	<p><i>Built Environment and Infrastructure Assets:</i> e.g. robustness and redundancy of critical infrastructure, land use and urban design etc.</p> <p><i>Governance and institutions Assets:</i> e.g. collaboration, education and training etc.</p>
<ol style="list-style-type: none"> 1. Natural 2. Economic 3. Social 4. Physical 5. Institutional 	Ribeiro & Goncalves (2019)	<p>The article features 11 characteristics of urban resilience</p> <p>Broader understanding of urban resilience, its characteristics and what kind of indicators should be prioritized for measuring urban resilience which, in turn, leads to understanding of what kind of policies must be prioritized</p>	No clear indicators

Appendix B: 100 Resilient Cities and the C40 Climate

100 Resilient Cities

The Rockefeller Foundation pioneered the 100 Resilient Cities (100RC) programme which ran from December 2013 until April 2019. The programme was part of the Foundation's Global Centennial Initiative. 100RC was dedicated to helping cities around the world become more resilient to various challenges of the 21st century, such as physical, social and economic ones (100 Resilience Cities, n.d.). The Rockefeller Foundation invested substantially so that 100RC could be built and thrive. Engagement with city leaders, communities, and the private sector allowed for considerable change in cities through The Rockefeller Foundation supporting resilience plans and implementation projects. Through the Foundation's investment, the cities were able to hire a Chief Resilience Officer, develop a resilience strategy, access pro-bono services from private sector as well as from NGO partners, and share and receive ideas, innovation and knowledge through the global network of Chief Resilience Officers (CROs). All 100 cities involved in the project developed individual City Resilience Strategies with technical support from a CRO (Resilient Cities Network, 2020).

The development of resilience strategies throughout the cities enabled 100RC to strategically use the resilience lens for planning a portfolio of actions meant to create higher-impact projects as to deliver benefits to various sectors, in particular to vulnerable communities. Moreover, the actions taken by 100RC led to the discovery that cities are limited in shaping and/or developing their most innovative ideas. This market gap hinders cities from delivering their most urgent objectives, and prevents funders from identifying pipelines of transformational projects (Resilient Cities Network, 2020).

Although the 100RC programme ended in April 2019, The Rockefeller Foundation and other funding partners go on supporting the Resilient Cities Network, a network created for further continuing the work of 100RC. The Resilient Cities Network aims to aid cities and their CROs in future-proofing their communities and critical infrastructure (Resilient Cities Network, 2020).

C40 Cities Climate Leadership Group

C40 continues to be a leading network on mitigating the risks of climate change by using innovative and effective approaches.

The C40 Cities Climate Leadership Group is a “global network of large cities acting to address climate change by developing and implementing policies and programmes that generate measurable reductions in both greenhouse gas emissions and climate risks” (C40, n.d.-b).

The network was started in October 2015, when the Mayor of London Ken Livingstone gathered representatives from 18 megacities in order to act and cooperate on reducing greenhouse gas emissions. An agreement was reached between these cities to create procurement policies and alliances for accelerating the uptake of climate-friendly technologies and influence the market place. The Clinton Climate Initiative (CCI) became a delivery partner to what would soon become the C40 network. Both organisations worked towards delivering world-class projects for optimizing emissions reductions (C40, n.d.-b).

Mayor Livingstone served as first Chair of the C40, he established the C40 Secretariat in London, set up the Steering Committee and initiated the use of C40 workshops to exchange best practices between the C40 Cities. In coming years, as the Chair changed, multiple actions and plans have been developed and implemented: the launch of practical action initiatives for cities, for instance, the C40-CCI Climate Positive Development Programme and the Carbon Finance Capacity Building programme (2009), full integration of C40 with the CCI Cities Program (2011), thus C40 executives and staff working together with CCI City Directors and programmatic teams to support climate action in cities, new C40 partnership with the World Bank and ICLEI – Local Governments for Sustainability – for accelerating climate action in cities through streamlined financing, greenhouse has accounting and uniform reporting. In collaboration with the Carbon Disclosure Project and ARUP – a British multinational professional services firm providing engineering, architecture, design, planning, project management and consulting services for all aspects of the built environment – two reports were created emphasising the role of measurement and transparency in tackling climate change in megacities (C40, n.d.-b).

Appendix C: C40 Membership Categories

The steering committee consists of 13 cities elected by the members of the C40 network. The innovator cities are ones that do not qualify as megacities, yet have shown clear leadership in environmental and climate change work. Megacities are cities with a population of 3 million or more, and/or metropolitan area population of 10 million or more or is one of the top 25 global cities, ranked by current GDP output, at purchasing-power parity. Lastly, the observer cities are, as short-term category, new cities applying to join the C40 for the first time, and, as

long-term category, are cities that meet the megacity and innovator city guidelines and participation requirement, yet for various regulatory or procedural reasons, are unable to approve participation as a megacity or innovator city (C40, 2012).

Appendix D: Codebook

Coding Round 1

Public policy: a catch-all code for all policies regarding the flood risk.

Coding Round 2

Vulnerability: code which describes the exposure of various areas to the flood risk (e.g. infrastructure, community).

Addressing climate change: these are the codes which describe the methods through which threats determined by climate change are meant to be addressed.

Code	When to use
Adaptation	Efforts for improving the ability of various areas to adjust to the flood risk
Resilience	Efforts for improving the ability of various areas to bounce back from shocks and stresses produced by the flood risk
Mitigation	Efforts for the management and control of the flood water movement (e.g. redirecting the flood run-off)

Coding Round 3

Dimensions: these are the codes which describe the five drivers of resilience. The dimensions encompass indicators useful for measuring resilience.

Code	When to use
Environmental	Creating maps for observing the extent to which areas are exposed to floods as to protect the natural environment
Economic	Keeping track of public finances, ensuring business continuity planning, and the extent to which there is integration with regional and global economies as to ensure appropriate flood risk management (including recovery)

Social	Regarding the community as an element that must be protected from threats like floods, and involved in actions for combating these issues (sanitation, skills and training, emergency response, community support, engaged citizens, protection of livelihoods, housing, drinking water, food supply, energy supply, medical care)
Institutional	Government and other public bodies coordinating to monitor the city and hazards, assess risks, gather and manage data as to properly make decisions for emergency management, land use and zoning, and preparing and making communities aware of the flood risk
Infrastructure	Infrastructure (e.g. communications, transport, buildings etc.) being protected and maintained through codes, standards and enforcement actions as to allow the continuity of critical assets and services even when facing floods and their aftermath