From Dichotomy to an Integrated Approach: Cities’ Benefits of Integrating Climate Change Adaptation and Mitigation

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Received: 21 August 2020; Accepted: 11 September 2020; Published: 15 September 2020

Abstract: Cities are facing impacts of climate change and encountering risks such as extreme weather events, while cities are also aiming to contribute to their mitigation goals by reducing greenhouse gas emissions. However, the differences in characteristics of climate change mitigation and adaptation have shown the possible reasons for a dichotomy in climate policy. This has motivated us to further look into whether cities could integrate their actions in climate change mitigation and adaptation in their planning and how they achieve benefits to overcome the dichotomy. To answer our research question, we have developed an analysis framework built on the endogenous risk theory to analyse how cities overcome the different characteristics to integrate their climate strategies and obtain benefits. The theory of endogenous risk involves seeing both climate change mitigation and adaptation as risk reduction strategies because both of them aim to reduce climate risks and can be carried out by actors who perceive such risks. Therefore, the actors will be more willing to integrate and implement both mitigation and adaptation policy. Our results show that mitigation and adaptation in cities are interlinked and that benefits of an integrated climate change policy exist. A list of entry points how cities overcome the dichotomy are also identified. Our research outcomes also provide a list of benefits identified by the cities in their integrated climate strategies and we call for more public disclosed data for future research and policy assessments.

Keywords: climate change adaptation; cities; mitigation; benefits; risks

1. Introduction

To curb climate change, efforts at the international, national, municipal and local level are aiming to contribute to the Paris agreement [1] on climate change to limit global warming to 1.5 °C. Most studies as well as the global political agreements such as the United Nations Framework on Climate Change Convention (UNFCCC) focus on international and national levels [2] and started discussions on mitigation and adaptation in a separate manner. Cities are facing impacts of climate change, especially when impacted by extreme weather events. Cities are willing to act and their actions in adaptation to climate change are often driven by climate risks [3]. Experience in extreme climate events is one of the drivers for climate adaptation planning [4]. Previous studies showed that cities show climate actions in urban planning, agriculture and forestry sector [5–7], and they emphasise the importance of integrating mitigation and adaptation instead of seeing them as separate policies and solutions. Emphasis on the importance of linking both climate efforts in long-term strategies has been stressed in the previous studies [8,9] but solutions for overcoming the dichotomy of mitigation and adaptation in
climate actions are not yet finalised. These linkages are worth exploring, since they are relevant to policymaking. Therefore, this motivated our study to focus on exploring how cities combine climate change mitigation and adaptation, and their outcomes of integrated climate strategies.

Kane and Shogren propose the theory of endogenous risk for integrating mitigation and adaptation [3,10]. The theoretical framework of endogenous risk sees both climate strategies as risk reduction strategies because both of them aim to reduce climate risks and can be carried out by actors who perceive such risks. Thus, there are two effects in mitigation and adaptation: complementing effects and substituting effects. When mitigation complements adaptation, mitigation increases when adaptation increases, and vice versa. When substituting effects take place, mitigation increases (decreases) when adaptation decreases (increases), and vice versa. Maladaptation is an example of a substituting effect. Our study aims to find empirical cases of complementing effects and the benefits cities obtain from integrated climate strategies. Therefore, we decided to focus on the complementing effects of endogenous risk in this study.

Endogenous risks are explained in some models as the damages or impacts due to climate change and they are intrinsic within the system depending on the greenhouse gas emissions [11]. If we account the greenhouse gas emissions and climate impacts in one model, the probability and distribution of extreme events would depend on the temperature change and therefore it is an endogenous risk [12,13]. Concrete examples on how investments in climate actions could have complementary effects based on endogenous risk theory are: reforestation could contribute to adaptation by reducing temperature and to mitigation by reducing emissions, which could reduce long-term risks of climate change [14]. The argument is that if we postpone the mitigation efforts, it may lead to irreversible climate impacts [15].

There is a gap to fill involving more research on the local level to find out whether local adaptation conflicts with mitigation and to examine the link between local climate change adaptation and mitigation empirically [8]. A systematic study to include social and economic factors in cities is needed [16]. Different from the resource allocation point of view, the emissions are driven by the economic activities and climate policy and therefore the risks are endogenous and could be determined by the measures taken within cities [17]. The idea of endogenous risk theory is to remind actors, like cities, that the future risks depend on their actions. This has motivated us to carry out an analysis to find concrete examples to support the theoretical foundation and at the same time to provide cities with entry points to follow.

Looking at the history of climate policy and scientific research, mitigation was the focus at the early stage of development, even though adaptation was crucial and needed by vulnerable communities [18]. One main reason for this was that adaptation was only seen as the solution when mitigation was not feasible. Later, adaptation was recognised as important, but was seen and applied as a separate solution and independently from mitigation. There was a gap in research and practice to study the synergies and trade-offs of mitigation and adaptation [2]. The theoretical foundation of this paper is built upon the differences identified in the previous studies [9,19]. Thus, it is important to fill this gap by studying the interactions between local mitigation and adaptation and finding out what synergies of both co-exist. The intention of this paper is to explore how climate change mitigation and adaptation are integrated in cities and which benefits arise from this integration. Therefore, our research question is: how do cities integrate climate change mitigation and adaptation to obtain benefits? To answer the research question, we first identified the benefits of cities’ integrated climate strategies, and looked into the specific city plans to find the entry points how these cities overcome the dichotomy to integrate their climate change policy.

Table 1 lists the characteristics of climate change adaptation and mitigation and their advantages as well as potential obstacles, especially for implementing adaptation [9,19]:

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**Table 1**

| Characteristics | Adaptation | Mitigation | Advantages | Obstacles |
|----------------|------------|------------|------------|-----------|
|                |            |            |            |           |
|                |            |            |            |           |
|                |            |            |            |           |
Füssel and Klein explained the characteristics of mitigation and adaptation and clearly point out the fundamental differences between both climate solutions and provide reasoning on why implementing both strategies might sometimes have trading-off effects at the local level [15]. Füssel and Klein pointed out that the trade-off effects originate from the fundamental difference in the nature of mitigation and adaptation: scale of effects of actions and their outcomes could create free-rider problems. Thus, sometimes these characteristics make it difficult to implement integrated climate strategies at the local level. The challenges which local adaptation faces include three main points. As described in Table 1, first of all, a main argument to focus on for mitigation is that some unavoidable damages such as a rising sea level faced by island states could only be solved by ambitious and urgent mitigation. Second, the issue of fairness is raised especially in the context of adaptation in non-industrialised countries because adaptation means that vulnerable communities have to pay the price, while the developed nations investing in mitigation seem to justify the polluters-pay-principle. Thirdly, in terms of methodology to quantify, monitor and verify greenhouse gas (GHG) emissions, it is important to use the easier one due to the universal unit applied. However, measuring and monitoring the non-monetary outcomes of adaptation still remains a challenge in climate adaptation research and practice communities. Meanwhile, mitigation at the local level also faces challenges. Overall, it is more difficult to convince cities than nations to mitigate because the effects depend on international cooperation and are also on a very long-term scale (it could take decades to see the effects of mitigation) [10]. Knowing the challenges faced by both local mitigation and adaptation motivated the development of this paper to look into the cities which take on both climate actions. Adaptation to climate change has started to be recognised as an integrated part of climate solutions together with mitigation [20,21]. It is therefore important to study the effects of interactions in climate change policies.
because they could create synergies [21]. This links to the complementing and substituting effects of the endogenous risk theory and our study focuses on whether complementing effects take place in cities when integrating climate change mitigation and adaptation.

This paper proposes a framework to analyse how cities integrate their climate strategies. We used the theory-based framework discussing the different characteristics of climate change mitigation and adaptation [9,19] to examine the climate change strategies in cities to identify their benefits and overcoming factors, as well as to find out how cities integrate their long-term strategies for climate change. The motivation of this paper is to provide cities with a series of concrete examples of how climate actions could be integrated. Hopefully, this could serve as a pathway for cities to follow and at least to capture the low-hanging fruits. This paper aims to provide a list of concrete win-win adaptation measures which could be transferred and replicated to other cities facing similar climate impacts.

2. Materials and Methods

The analysis is based on the stocktaking approach of adaptation and the justification of this method is to have the initial steps to be able to make linkages to other climate strategies and development activities [22,23]. Building on the stocktaking approach [23], we followed the four-step method to carry out our analysis, but to fit the objectives of our analysis to include both mitigation and adaptation, we extended the approach by including both climate actions and modified the steps as follows: Step 1: Obtaining consensus on the objectives of integrated climate change strategies; step 2: Agreeing on the sources of evidence and search methods; step 3: Categorising the integrated climate measures according to the framework [9,19]; step 4: Evaluating the benefits based on the concept of the typology [24]. The objective of this approach was to document and gain the insights on the progress of the adaptation in cities in the published literature. The categories of integrated mitigation and adaptation and their benefits cover the main aspects mentioned in the available literature [9,19,24] and they are meant to summarise the most critical categories.

The first step of the analysis is important to use to obtain consensus because it identifies the common definitions and terminologies throughout the study and analysis [23]. We agreed to aim this study at looking into the integrated climate change strategies by including both climate actions and its benefits. The objectives are to find out how cities overcome the dichotomy of climate change mitigation and adaptation and its benefits. After agreeing on the research objectives, we continued with a set of agreed upon sources of data and search methods.

Second, we have selected our cities according to a systematic mapping [22]. The databases searched were EBSCO Host, Emerald, Social Science Research Network/SSRN eLibrary, ScienceDirect, Web of Science, Wiley, etc. The keyword search combination was identified according to the previous research and our research focus. The key words and relevant terms used for searching in all available database include:

“climat*” AND “benefit*” AND “cit*”
“adapt*” “opportunit*” “urban”

Only English and peer-reviewed publications were selected for screening. The search focuses on English language publications and full articles. Working papers which specifically note “not for citing” are also excluded. Each selected article was screened wholly to determine whether it was related to our research question. Each of the documents was reviewed and a systematic literature review was carried out to identify the benefits of integrated climate change in cities. The cities chosen for our database were collected by using a systematic literature review from peer reviewed publications; we also used public disclosure data from the Carbon Disclosure Project (CDP), C40, World Council on City Data, cities’ published adaptation plans and available open access cities’ data. Each city as a case study listed in a paper was documented as a record in our dataset. To ensure that our sample differentiates the disaster reduction and future climate change impacts, the use of climate projections or scenarios was the criteria for selecting the climate change adaptation studies. Then we continued to obtain mitigation...
data from open access databases in order to find out the emission reduction targets and efforts in each city. By using systematic mapping [22], we included 35 cities (including sub-state or non-national level case studies) worldwide as shown in the Table 2. The design of the study was to identify concrete examples from integrated climate strategies from the systematic mapping and the objective was to learn from the existing studies.

Third, we analysed the climate strategies from an integrated perspective, to find out whether such integrated solutions yield benefits despite the different characteristics of mitigation and adaptation; the coding framework was developed based on their different characteristics [4,16].

At the last step, we used the typology of benefits as the basis and modified it to focus on the risk reduction and opportunities exploitation to evaluate the benefits of the cities’ integrated climate strategies [24]. We followed the categorising and coding methods developed and tested by previous studies to best identify the integrated climate actions by using the objectives agreed to in our theoretical foundation and used the frameworks to provide a useful component categorisation of types of mitigation and adaptation to obtain the results [23,25]. Step 4 of Figure 1. shows the coding framework used for identifying and evaluating the benefits typology. The following list shows the literature and data sources assessed in the study along with the selected cities sample and their countries of origin.

Table 2. List of cities and data sources.

| City                                      | Country               | Data Sources |
|-------------------------------------------|-----------------------|--------------|
| Aarhus                                    | Denmark               | [26]         |
| Aitutaki                                  | Cook Islands          | [27–30]      |
| Antwerp                                   | Belgium               | [31,32]      |
| Athens                                    | Greece                | [33]         |
| Atlanta                                   | USA                   | [28,34–36]   |
| Avariu-Ruatonga                           | Cook Islands          | [27]         |
| Bilbao                                    | Spain                 | [31,37]      |
| Bologna                                   | Italy                 | [38]         |
| Brisbane                                  | Australia             | [28,38–40]   |
| Cairns                                    | Australia             | [41,42]      |
| Copenhagen                                | Denmark               | [28,43]      |
| Cox’s Bazar Beach                        | Bangladesh            | [27,35,44]   |
| Dhaka                                     | Bangladesh            | [28,43,45]   |
| Durban, Ethekwini                         | South Africa          | [46–49]      |
| Emfuleni                                  | South Africa          | [43,49]      |
| Gothenburg                                | Sweden                | [43,50,51]   |
| Heraklion                                 | Greece                | [33,52]      |
| Ho Chi Minh City                          | Vietnam               | [33,54]      |
| Jersey Shore/New Jersey                   | USA                   | [35,56]      |
| London                                    | UK                    | [37,58]      |
| Madrid                                    | Spain                 | [59,60]      |
| mainland Miami-Dade County, Florida       | USA                   | [61,62]      |
| Melbourne                                 | Australia             | [28,35,36,41]|
| Flathead County                           | USA                   | [63–65]      |
| Philadelphia                              | USA                   | [34,66]      |
| Phoenix                                   | USA                   | [34,66]      |
| Prague                                    | Czech Republic        | [60,67]      |
| Sao Paulo                                 | Brazil                | [43]         |
| Seoul                                     | Korea                 | [68–70]      |
| Shenyang Metropolitan Area                | China                 | [71,72]      |
| Singapore                                 | Singapore             | [28,35,73]   |
| Somerville, Massachusetts                 | USA                   | [74]         |
| Sydney                                    | Australia             | [28,34,35,41]|
| Thessaloniki                              | Greece                | [33,75]      |
3. Results

Using the stocktaking approach described in the method section, we examined 35 cities’ climate adaptation and mitigation strategies to identify the concrete examples of integrated climate strategies. The cities are able to provide examples of benefits and the results also show that there are possibilities to achieve win-win options to overcome the climate policy dichotomy. One of the distinct differences between mitigation and adaptation is that mitigation is usually proactive while adaptation is usually reactive to the projected climate impacts. However, cities are able to show that proactive actions in adaptation could achieve benefits from integrated adaptation and mitigation. For example, the measures of using green roofs, vegetation and ventilation in building designs adopted by cities facing heat waves such as Antwerp, Bilbao, Gothenburg and Madrid are adaptation as well as mitigation strategies [34,59,60,66]. Such actions adapting to extreme weather events could be designed to consider energy efficiency and carbon sequestration for achieving synergies. This principle applies in the discussions of ancillary benefits, which show that it is a win-win strategy for integrated climate actions. For cities like Bologna, Copenhagen, Dhaka, Emfuleni, Gothenburg, Madrid, Prague, Sao Paulo and Shenyang, green roofs and greening are the examples provided to reduce impacts of heatwaves as well as carbon emissions.

One of the important discussions in the adaptation and mitigation dichotomy is about the justice issue of polluters-pay-principles. Cases like Aitutaki, Avatiu-Ruatonga and Cox’s Bazar have carried out actions to adapt to sea level rise or sea-surge caused flooding [27]. At the same time, they also dedicate efforts towards meeting emissions reduction targets due to national commitments in mitigation. From this we could learn that national commitments could play an important role in local actions towards climate change. This also adds to the example of endogenous risk theory: cities recognise that both climate strategies work to reduce climate risks and therefore must be acted upon.

Cities act because they see benefits in such actions. The typical discrepancy between payers receiving benefits in mitigation and adaptation is the free-rider problem. This means mitigation actions require global and collective efforts, while adaptation might not face the same issue. However, our examples show that the benefits are always perceived from combating climate change. Cities are willing to act to facilitate both mitigation and adaptation once benefits are perceived. In cities like Aarhus, Antwerp, Bilbao, eThekwini, London, New Jersey, Seoul and Somerville, they have shown that payers are willing to pay for reducing climate risks due to the payers receiving their own benefits. For example, infrastructure investment in flood prevention measures caused by extreme rainfall, sea level rise and storm water could also take into account a more sustainable approach and integrate mitigation measures into their designs. The cities like Copenhagen, Dhaka, Emfuleni, Gothenburg and
Sao Paulo are capturing ‘low hanging fruits’, namely win-win, no regrets or low regrets options in their integrated climate options by integrating waste management and sustainable building designs for climate change adaptation and mitigation in their newly constructed buildings. In Brisbane, Melbourne and Sydney, the cities provide examples involving newly designed housing, through which the impacts of cyclonic winds could be reduced and which are constructed to be green as well [76]. Better management of waste could also provide benefits for both the waste management and climate policy [43].

Energy transition and transition to green mobility in the cities are good examples of integrated strategies. The cities of Atlanta, Philadelphia and Phoenix show that the effects of reducing climate risk by addressing urban heat islands could actually reduce risks concerning public health and heat induced deaths. Such risk reduction strategies could overcome the dichotomy of lead time because they could bring immediate as well as long-term effects. The cities of Athens, Heraklion and Thessaloniki are facing sea level rises in their coastal zones and are utilising the support of real option analysis and modelling to provide information and flexibility for policy-making to deal with the issue of certainty in climate decision-making. Monitoring tools are proposed for adaptation to overcome the difficulties mentioned, for instance the use of a ‘prepare and monitor approach’, which is similar to the real options approach. Overall, the cities’ cases show that mitigation efforts require global collaboration but could be done within different sectors, while adaptation requires cross-sectoral cooperation and across-levels. Cities are able to communicate and engage with stakeholders across levels and sectors. To support the synergetic benefits effect of endogenous risk theory, the Table 3 provides the representative examples from the 35 cities in which various types of benefits could be obtained.

From our results as shown in the Table 4, we could see that integrated climate strategies could yield benefits, and these benefits structured by the typology provide an overview as well as concrete examples for cities to act to obtain the benefits. According to the results, the cities show benefits in mainly four different sub-categories: (1) Understanding risks to better prepare for climate change impacts, (2) Avoiding or reducing the risks, (3) increased efficiency (including costs savings and the net present value of economically viable options), and (4) ancillary benefits from other aspects (e.g., mitigation and adaptation co-benefits, health co-benefits, etc.). The cities show that they could obtain benefits from both reducing risks and exploiting opportunities. For example, saving costs by increasing the efficiency of water and energy use are useful options. Furthermore, revenues from carbon reductions and co-benefits in health sectors serve as the main sources of benefits of integrated climate strategies.

The list of integrated mitigation and adaptation options shows that our results are confirming the complementing effects of endogenous risk theory: the cities could overcome the dichotomy when their ultimate goal is to reduce climate risks. The results also show that their integrated climate actions could bring benefits. This outcome has expanded the discussion in the literature by adding a synergetic perspective for the differences discussed in the framework [9,19]. This also contributes to the reasoning on how climate actions could motivate actors to move towards a more climate-resilient society.
Table 3. Representative examples of cities’ integrated approaches and benefits.

| Characteristics               | Representative Examples of Cities’ Integrated Strategies and Benefits                                                                 | The Relevant Cities                                      |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| Distinct characteristics      | Reduced energy costs and increased health and well-being: nature-based solutions like green roofs and ventilation in building-design to adapt to heatwaves. | Antwerp, Bilbao, Gothenburg, Madrid                      |
| Scale of effect               | Cities dedicated to both mitigation and adaptation actions contribute to carbon emissions reduction and at the same time reduce the impacts of climate change. Cities recognise that collective actions at the local level could contribute to both. | All 35 cities                                            |
| Polluter pays principle/Equity | Reducing carbon emissions to reduce risks of sea level rise in the long term and at the same time adapt to sea-surge triggered flooding. | Aitutaki, Avatiu-Ruatonga, Cox’s Bazar                  |
| Payer benefits                | The benefits motivates cities and therefore cities act towards both mitigation and adaptation: the newly designed housing reduces the risks of flooding (from extreme rainfall, sea level rise, cyclonic winds or storm water), and heat stress. Such greener buildings also have higher energy efficiency. | Aarhus, Antwerp, Bilbao, eThekwini, London, New Jersey, Seoul, Somerville |
| Benefited systems             | In terms of crops, Without adaptation, all crop types’ yields will decrease, but with adaptation, most crops (9 out of 12) will be optimal. | Brisbane, Flathead County, Melbourne, Sydney             |
| Ancillary benefits            | The ancillary benefits show that both mitigation and adaptation is a win-win strategy. Green roofs and greening are the main examples used to reduce heatwaves as well as carbon emissions. | Bologna, Copenhagen, Dhaka, Emfuleni, Gothenburg, Madrid, Prague, Sao Paulo, Shenyang |
| Life time                     | The cities are capturing ‘low hanging fruits’, namely win-win, no regrets or low regrets options in their integrated climate options. The range of strategies include waste management and sustainable building designs in cities. | Copenhagen, Dhaka, Emfuleni, Gothenburg, Sao Paulo       |
| Lead time                     | Energy transition and green mobility could reduce urban heat island and public health risks and could overcome the challenge of justifying useful actions with a long lead time because they bring immediate and long-term benefits to motivate cities to invest in such measures. | Atlanta, Philadelphia, Phoenix                           |
| Certainty                     | For coastal zones facing sea-level rises, the support of analysis like real option analysis and modelling provide information and flexibilities for policy-making. | Athens, Heraklion, Thessaloniki                         |
| Cooperation degree required   | Mitigation efforts require global collaboration but could be done within different sectors, while adaptation requires cross-sectoral cooperation and across-levels. Cities are able to communicate with and engage stakeholders across levels and sectors. | All 35 cities                                            |
| Monitoring                    | Several monitoring tools are proposed in adaptation to overcome the difficulties mentioned, for instance the use of a ‘prepare and monitor approach’, which is similar to the real options approach. | Somerville (Massachusetts)                              |
Table 4. Benefits of integrated climate change mitigation and adaptation.

| Adaptation Strategies                | Benefits Typology          | Risks Type                                      | Description of the Benefits Arising from Adaptation                                                                 | Cities                                      |
|--------------------------------------|-----------------------------|-------------------------------------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
| Delivering adaptation actions        | Avoiding or reducing the risks | Flooding due to extreme rainfall and storms      | Flood protection such as expanding urban drainage system or upgrades of existing infrastructure such as green roofs and porous pavements. | Aarhus, London, Seoul, Singapore, Somerville, Massachusetts, Brisbane, Cairns, Melbourne, Sydney |
|                                      | Wind (e.g., cyclonic winds) |                                                  | Newly designed housing against wind and cyclones to reduce risks and loss.                                          | Atlanta, Philadelphia, Phoenix              |
|                                      | Extreme temperature (urban heat islands) |                                             | Heat management strategies to reduce heat-related mortality rate by using combinations of vegetation and albedo enhancement to offset. | Jersey Shore/New Jersey                    |
|                                      | Sea level rise to coastal zones |                                             | Redesigning urban planning to make transportation routes and touristic areas more climate-resilient.                | Athens, Heraklion, Thessaloniki            |
|                                      | Sea level rise in coastal zones | Understanding the risks                         | Flexibilities offered by the real option analysis valuation method.                                                | Flathead County                            |
|                                      | Agricultural production due to climate change |                                             | Simulation of crop enterprises, farm sizes, soil types, crop yields and prices and providing information to understand the risks to be better prepared for future climate impacts. | Aarhus                                     |
| Exploiting new opportunities         | Ancillary benefits          | Extreme rainfall                                 | Pipe enlargement, infiltration and open urban drainage system to avoid or reduce extreme rainfall triggered flooding, or even increased property prices. | Aitutaki, Avatiu-Ruatonga, Cox’s Bazar Beach |
| Adaptation Strategies | Benefits Typology | Risks Type | Description of the Benefits Arising from Adaptation                                                                 | Cities                                                                 |
|-----------------------|-------------------|------------|----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Waste                 |                   |            | Reduced land and water pollution; reduction in air-pollution related illness; reduced costs of air-pollution related healthcare; enhanced energy security and livelihood opportunities and carbon reduction and financial benefits of Carbon Credits (CERs). | Copenhagen, Dhaka, Emfuleni, Gothenburg, Sao Paulo                       |
| Extreme temperature (heat) |                   |            | Energy cost reduction and health co-benefits: green roofs to reduce the use of air conditioning and heat exposure time effects. | Madrid                                                                 |
| Air pollution and health risks |                   |            | Reduction in air pollutants and greenhouse gases (GHGs) emissions.                                                    | Shenyang Metropolitan Area                                              |
| Increased efficiency (including cost saving and positive NPV) |                   | Sea level rise | Adaptation options investment for sea level rise are cost effective under the certain condition (e.g., a 2.11 meter sea level rise scenario in combination with a high socio-economic scenario and a discount rate of 2.5%). | Durban, eThekwini, Ho Chi Minh City                                      |
| Water-energy-food nexus |                   |            | Energy efficiency and water efficiency (demand side management) as an integrated nexus approach.                      | Bologna                                                                |
| Extreme temperature (heat) |                   |            | Positive net present value from the heat warning system costs, reduced health professional costs for patients due to heat, energy savings due to decreases in cooling costs and a carbon footprint reduction. | Antwerp, Bilbao, Madrid, Prague                                         |
4. Learning from the Cities

This section aims to provide useful insights from the selected cities’ plans and replicable results as entry points for other cities to adopt. The cities were selected due to their availability of city plans, institutional structures, measures and representation of examples from both the Global South and the Global North. As a result, the cities of Brisbane, Cairns, eThekwini (including Durban) and Thessaloniki were selected to be illustrated in this section. We have looked into the city plans of these cities to identify their approaches for overcoming the obstacles of integrating climate change actions. This is the list of entry points as replicable insights for other cities to learn from:

1. Use of climate information, modelling or assessment tools for projecting climate impacts and identifying vulnerabilities.
2. Partnerships are important: partnering with private sectors, communities and existing networks.
3. Making use of drivers from international, national and sub-national levels.
4. Embedding climate change adaptation and mitigation into planning and implementation.
5. Co-create and co-produce with citizens and diverse groups.

4.1. Use of Climate Information, Modelling or Assessment Tools for Projecting Climate Impacts and Identifying Vulnerabilities

The cities identify the vulnerabilities through the available assessment tools. Most of the cities use climate projections to understand future climate risks in different scenarios. Concerning the future climate scenarios the cities used as their reference for analysis of adaptation, almost all of the cities have taken into account the RCP8.5 scenarios, which are the worst case scenarios among four scenarios. The only exception is Durban, eThekwini, where the best case scenario of RCP2.6 was used in the adaptation analysis. Among all 35 cities, 6 cities (Atlanta, London, Philadelphia, Phoenix and Seoul) have taken into account all possible scenarios (RCP2.6, 4.5, 6.0 and 8.5) in their adaptation analysis. The timelines cities referred to in the adaptation scenario go from as near-term as 2020 to as long-term as 2100. By having a futuristic climate view, cities prepare themselves based on the projections and magnitude of impacts they are facing. The climate information provides basic first steps for cities to react upon. To apply the endogenous risk theory in practice, it is important to make the connection that actions in mitigation have the impacts on the scenario which adaptation actions are aiming at. The application and interpretation of projected climate scenarios are used in the field of climate change to represent the future possible emission pathways, and they are adopted and should be widely used in both mitigation and adaptation policy planning and implementation.

4.2. Partnerships, Partnerships and Partnerships

Partnerships are mentioned several times in all city plans. Partnering with the private sector and local communities is important to prepare for and reduce the climate risks so investments and long-term decisions could incorporate climate change. This approach also aims to identify opportunities for new products or services. Two Australian cities, Cairns and Brisbane, incorporate private sectors in their adaptation strategies by having climate risks considered in corporate strategic planning and investment decisions [39,40,42]. Further than that, partnerships could also be built on existing networks to leverage more resources for mainstream climate change actions in cities. One way of implementing is to partner with other natural management related projects to incorporate climate adaptation into the on-the-ground projects. Cairns provides the example that they integrate adaptation land-use planning and an energy transition to reduce dependence on oil to increase community resilience in the area of energy security.

4.3. International, National and Sub-National Drivers

The international climate regime, like the Paris agreement, is pushing for global political discussions and commitments and it also trickles down to the national climate change adaptation plans and
commitments of sub-national levels to drive actions in cities. The cities could make use of the waves of global calls on climate emergency and national commitments to drive cities’ actions forward. For example, a voluntary forum calling for cities’ actions, Covenant of Mayors for Climate & Energy, calls for member cities to commit to reduce carbon emissions. Thessaloniki is one of them, as their commitments play a role to influence their policy-making. Other examples of how national commitments could play a role to influence the local level are Aitutaki, Avatiu-Ruatonga and Cox’s Bazar. These sub-national actors in various islands are adapting to sea-level rise and at the same time committing to mitigation, since they are also contributing to the national goal of carbon emission reduction.

4.4. Embedding Climate Change Adaptation and Mitigation into City’s Policymaking, Planning and Implementation

Embedding climate change into land use and coastal planning is also important, as shown in the eThekwini metropolitan municipality. Durban integrates disaster management and climate adaptation policy into their coastal policy. The integrated climate actions are targeting reducing the energy and water costs for citizens. Similar to Durban, Thessaloniki integrates mitigation and adaptation strategies by reducing the emissions from switching to electric vehicles. This improves air quality and provides citizens’ benefits by improving public health. Cairns also builds its climate strategy to reduce climate change impacts by having actions both in mitigation and adaptation embedded in the council’s climate plan. Under this logic, Cairns sets reduction of carbon emissions as one of the climate implementation strategies. According to the priorities of risks identified in the city, climate change could also be embedded into other important issues in the city, for instance, health, water and disaster management, as in Durban. The example of Thessaloniki shows that the city establishes a resilience framework to include the most affected dimensions of the city and to plan actions based on the dimensions and relevant factors identified. The city’s resilience framework includes also socio-economic aspects and tackles health and built environment topics. As a result, an implementation plan to tackle air quality and traffic is carried out to reduce air pollution, increase the health benefits of citizens and at the same time reduce carbon emissions to reduce impacts on citizens in multiple aspects. Embeddedness to combine important issues together with climate change is an important strategy for cities, especially in the crisis of a pandemic time where opportunities should be looked into further by combining climate change and health issues.

4.5. Co-Creation, Co-Production and Stakeholder Engagement

To co-create the adaptation process with stakeholders by being inclusive across different sectors and groups such as indigenous groups and citizens is important. Durban indicates the importance of a transparent process and provides an example where a formal cross-sectoral partnership could be built with citizens, academics, public sectors, businesses and private sectors. All stakeholder groups are engaged in the whole process and given a role to play as an interim committee to contribute to the climate mitigation and adaptation process in the city.

5. Discussion

The dichotomy of mitigation and adaptation has long been debated due to the justice issue of polluters-pay-principles. This was also often thought to be the barrier at the local implementation level in that local actors would have to choose one of the two, as they could be competing for local resources and capacity. However, from our results we learned that the local communities from both developed and non-developed states are also taking the responsibility for mitigation while adapting to climate impacts like sea-level rises. The planning and implementation could be integrated to achieve beneficial outcomes locally and globally. From this point of view, the results provide examples of how global and local benefits could overcome the polluter-pay-principle injustice issue. We provided concrete examples of benefits to show best practices for more local communities facing the same dilemma to learn from to overcome the dichotomy of climate policy.
Our study followed the benefits typology and we expanded the benefits framework by providing a more detailed explanation of benefits to have answered the question ‘how do cities integrate climate change mitigation and adaptation to obtain economic, social and environmental benefits?’ with detailed definitions and concrete examples. The cities which integrate their climate strategies show benefits in their cases. Our results show that the benefits and synergies could overcome the dichotomy using different characteristics of mitigation and adaptation, and that an integrated approach of climate strategies is possible at the city level. Differences exist, but when it comes to reducing risks (in a longer or shorter term) to different climate impacts (e.g., heat waves), cities have strategies consisting of both mitigation and adaptation measures in place. This is consistent with the theory of endogenous risks showing complementing effects. By examining the publicly disclosed data and peer-reviewed publications, our empirical evidence has shown that cities could tackle climate issues from the angle of risk reduction through mitigation and adaptation and therefore integrate their climate strategies to obtain synergistic benefits.

City networks in both regional and global scales are common and popular nowadays. Concrete examples of such networks include C40, ICLEI, CDP, Resilient Cities, Mayors Covenant and others, and the systematic way of disclosing and evaluating cities’ integrated climate strategies still remains immature for both research and policy evaluation. Therefore, this paper hopes to raise this issue by pointing a direction of evaluating the cities in an integrated approach to have a more holistic overview. Our selection process has shown that the number of cities disclosing their mitigation and adaptation in both peer-reviewed publications and public disclosure database could be further encouraged in the era of open access data to encourage more cities and local authorities to disclose their actions on climate change. More efforts to increase the number of cities reporting their data could benefit the cities for future research and policy studies. Therefore, we would like to call for more cities disclosing more data in quantity and quality.

The field of urban climate research still has room to be explored. This paper limits its focus to publications in the English language but there may be abundant documents in other languages which could show important efforts made by the cities from non-English speaking countries. It is equally important to look into these documents and carry out an assessment to make their work accessible. Another interesting and important future agenda is to look into the political environment of cities to examine their influence on climate policy and implementation.

Mitigation and adaptation have differences in their nature but both have a clear common goal for cities: reducing risks, and by doing so, capturing benefits along the development pathway. Despite the differences in the scale of effects, all the cities in the study have either strategies or targets for mitigation and adaptation. We hope this paper plays a role to push forward local climate actions for both mitigation and adaptation by providing cities’ successful examples integrating them.

6. Conclusions

Various cities provide concrete examples of an integrated mitigation and adaptation approach in the sectors of urban planning, water, health, agriculture, etc., and the examples are able to show the synergies and benefits of such measures. The underlying theoretical framework of endogenous risk is to see both climate change mitigation and adaptation as risk reduction strategies because both of them reduce climate risks and can be carried out by actors who perceive such risks. Our results show that by integrating the mitigation and adaptation strategies, the cities receive synergetic benefits in their climate measures and the cities show their examples of how they could overcome the different characteristics to plan for mitigation and adaptation in an integrated approach. To minimise the discrepancy between adaptation and mitigation policy and actions in cities, it is important to ensure that the actions in mitigation are in line with the adaptation. We found that how cities overcome the mitigation-adaptation dichotomy matches with the risk reduction concept and therefore confirms the endogenous risk theory that both mitigation and adaptation are kinds of risk reductions and both strategies to climate solutions should be coupled to maximise their synergetic benefits, rather than
implementing them in a separate but counter-effective effort. At last, we hope our results of showing benefits obtained from integrated mitigation and adaptation could call for more cities to carry out integrated climate actions.

**Author Contributions:** Conceptualisation, J.-T.H.-L. and E.G.; methodology, J.-T.H.-L. and E.G.; software, J.-T.H.-L.; formal analysis, J.-T.H.-L.; writing—original draft preparation, J.-T.H.-L. and E.G.; supervision, E.G. All authors have read and agreed to the published version of the manuscript.

**Funding:** The first author would like to sincerely thank the German Academic Exchange Service (DAAD) for the scholarship which made this research possible (grant number 915308999). All of the authors wish to thank the three anonymous reviewers for very valuable feedback and comments.

**Conflicts of Interest:** The authors declare no conflict of interest.

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