Ecosystem-based Adaptation Measures in Climate Change Action Plans of Large Cities: An International Comparison

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Abstract

Cities are especially vulnerable to climate change, and the fast growth rate of cities, especially of large cities in the developing world, requires municipal authorities to take action. Ecosystem-based adaptation is a new, promising, affordable approach that harness nature and utilize ecosystem services in efforts to adapt to the negative impacts of climate change. In this thesis, climate change action plans of 18 large cities with population of over 5 million inhabitants are analyzed through directed content analysis, in order to find out to which extent are EbA measures applied, how thoroughly are they discussed in different parts of the action plans, whether sufficient preconditions for their implementation are presented, and whether the possibility of utilizing co-benefits of these measures is done systematically. Chapters 2 and 3 lay the theoretical framework, define Ecosystem-based adaptation and identify the measures relevant for urban areas. A city-by-city analysis presented in chapter 5, gives an overview on how EbA is present in the relevant planning documents of each case study city. In chapter 6, the results are summarized and compared both by city, and by EbA measure. To conclude, in chapter 7, the cities were grouped according to different political, economic and geographical conditions. A comparison between these groups shows which variables play a role in planning the application of EbA in the municipal level.

Zusammenfassung

Städte sind besonderes anfällig für die negativen Auswirkungen des Klimawandels und deren hohe Wachstumsrate, besonders in Großstädten der Entwicklungsländer, verlangt nach (regulierenden) Maßnahmen durch die Stadtoberhäupter. Ökosystembasierte Anpassung ist eine neue, vielversprechende und kostengünstige Methode, die die Natur und Ökosystemleistungen nutzt, um eine Anpassung an negative Klimaauswirkungen zu ermöglichen. In dieser Masterarbeit wurden Klimawandeleinsatzpläne von 18 Großstätte mit mehr als 5 Millionen Einwohnern analysiert, um die folgenden Fragen zu beantworten: Inwieweit sind Maßnahmen der Ökosystembasierten Anpassung in den Klimawandeleinsatzplänen berücksichtigt worden? Wie ausführlich wurden sie in den verschiedenen Teilen der Pläne diskutiert? Sind ausreichend Voraussetzungen für die Umsetzung der Maßnahmen diskutiert worden? Wurde das Thema Nebeneffekte systematisch behandelt? In Kapitel 2 und 3 wurde hierfür der theoretische Rahmen festgelegt, Ökosystembasierte Anpassung definiert und die genauen Maßnahmen, die für die Stadtplanung geeignet und relevant sind, identifiziert. Die in Kapitel 5 einzeln analysierten Fallstudienstädte geben einen Überblick darüber, wie präsent die Ökosystembasierte Anpassung in den relevanten Planungsdokumenten ist. In Kapitel 6 wurden die Ergebnisse zusammengefasst und Vergleiche zwischen den Städten und den verschiedenen Maßnahmen gezogen. Schlussendlich, in Kapitel 7, wurden die Städte bezüglich ihrer politischen, sozialen, ökonomischen und geographischen Bedingungen gruppiert. Ein Vergleich zwischen diesen Gruppen zeigte, welche Variablen bei der Planung der Anwendung von Ökosystembasierter Anpassung auf Stadtebene eine Rolle spielen.

Hiermit erkläre ich, dass ich die vorliegende Arbeit selbstständig und eigenhändig sowie ohne unerlaubte fremde Hilfe und ausschließlich unter Verwendung der aufgeführten Quellen und Hilfsmittel angefertigt habe.

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List of Abbreviations

Av.	Average
BRL	Brazilian Real
C40	Cities Climate Leadership Group
CAD	Canadian Dollar
CBD	Convention on Biological Diversity
CC	Climate Change
CO_2	Carbon Dioxide
EbA	Ecosystem-based Adaptation
EEA	European Environmental Agency
GBP	Great Britain Pound
GHG	Greenhouse Gas
GUD	Green Urban Design
HCMC	Ho Chi Minh City
ICLEI	International Council for Local Environmental Initiatives
INR	Indian Rupee
IPCC	Intergovernmental Panel on Climate Change
NYC	New York City
RQ	Research Question
UHI	Urban Heat Island
UN	United Nations
UNDP	United Nations Development Program
USA	United States of America
USD	United States Dollar

1. Introduction

Due to their physical characteristics, urban areas are especially vulnerable to the adverse effects of climate change (Stone, 2012: 74; IPCC, 2014, De Sherbinin et al, 2007). More than half of the world's population lives in urban areas (Van Bauern et al, 2012), and the rate of urban population is constantly growing (McDonald et al, 2011). As a result, developing new ways in which cities could adapt to the adverse effects of climate change is increasingly important (Wamsler, 2015).

EbA is a relatively new approach that systematically harnesses ecosystem services to buffer communities from the adverse effects of climate change (Wamsler, 2015; Gill et al, 2007; Munang et al, 2013). This approach is more cost-effective than other adaptation approaches, and provides opportunities for flexible and responsive win-win outcomes (Roberts et al, 2012). This approach is particularly useful in the case of developing climate change adaptation strategies on the city level and in the developing world, where a significant percentage of the population lives, where vulnerability to climate change is particularly high, and resources given to reach stated goals are often limited (Vignola et al, 2009; Van Bauern, 2012).

While the potential benefits from application of ecosystem-based adaptation measures, as defined and discussed in chapter 3.2, are widely studied, for example by Jones et al (2012), Munang et al (2013) and Perez et al (2010), there are not many studies which have examined the application of such measures on a broad scale. Wamsler et al (2014), Wamsler (2015) and Vignola et al (2009) dealt with mainstreaming EbA into planning and policy processes. Geneletti and Zardo (2016) have classified ecosystem-based adaptation (EbA) measures relevant to urban planning and examined their application in different planning levels of European cities. Some papers have been written examining specific case studies, for example Roberts et al (2012) examined the case study of Durban, Niemlä et al (2010) researched the consideration of ecosystem services in urban planning considering urban greening efforts across Finland and Mercer et al (2012) researched the potential of these measures in the Caribbean region. Reckien et al (2014), Heidrich et al (2013) and Baker et al (2012) studied urban climate change action in different regions, without a specific focus on EbA. Wamsler (2015) mentions that even though the concept attracts increasing attention, there is as yet little theoretical work regarding whether the concept is integrated in planning processes, and on how well pathways to implementation are made. Therefore, a knowledge gap can be observed for understanding the differences in both planning towards climate change and implementing these cost-effective solutions particularly in large cities, which in many cases are growing fast and in an unplanned manner, as well as in creating a base for comparison of the application of these solutions in the developed and the developing world.

In an attempt to contribute to the knowledge regarding the incorporation of EbA measures in climate change action plans of large cities, four questions will be answered in this thesis: To what extent are ecosystem-based adaptation measures considered in climate change action plans of large cities?; To what extent do the action plans provide a clear roadmap towards implementation of the planned EbA measures?; Are EbA measures discussed in the context of several benefits, and are opportunities for utilizing co-benefits and creating win-win solutions discussed?; What differences can be observed between different cities? Is it possible to categorize the strategies – if yes, according to which criteria?

As Reckien et al (2014) explain, many of the studies conducted in recent years about urban climate change action are based on self-report measures, such as interviews or questionnaires, which might incorporate bias. Analysis of climate change action plans would be a less subjective way to assess climate change response. Therefore, in order to answer these questions, municipal climate change action plans, as well as other climate change-related planning documents will be analyzed. This will provide an overview on which EbA-related actions are taken.

18 case study cities with more than 5 million inhabitants, from different geographical, socio-economic, political and climatic conditions, were chosen for the analysis. This thesis gives an overview of the extent to which EbA measures are being applied in municipal climate change action plans, and on the level of detail in which these measures are discussed. Furthermore, it attempts to give a picture regarding whether these action plans entail sufficient information and clauses that would create the right conditions for a successful implementation process, as well as whether the prospect of utilizing co-benefits and pursuing win-win solutions is sought for. To conclude, it will give an overview of the differences between the cities analyzed, and whether they correlate with the way EbA measures are incorporated, with an emphasis on the differences between cities in developed and in developing countries.

2. Large Cities

2.1 Urbanization Trends

As of 2007, half of the world's population lives in cities and urbanization is continuously increasing. In 2014, 54% of the global population lived in urban areas, and by 2050, the share is expected to rise to 66% (UN, 2014). All in all, 3 billion additional people are expected to live in cities by 2050 (McDonald et al, 2011). In North and South America, as well as parts of Europe, 75% of the population is already living in cities. In Asia and Africa, urbanization is growing rapidly (UN, 2014; Van Beuren, 2012). This pattern of fast growth is particularly relevant when discussing large cities, especially in the developing world. In recent decades, urban population growth has been happening predominantly in low and middle income countries (UN, 2014; Roberts et al, 2012).

The largest form of an urban area is commonly known as a megacity, yet there is no agreed definition of this term (Folberth et al, 2015). The most common definition is a city or a metropolitan area with more than 10 million inhabitants (UN, 2007; Molina and Molina, 2004; Glasow et al, 2013; Grimm et al, 2008), while other definitions set the number at 8 million inhabitants (Uitto, 1998). In some cases, two or more cities or metropolitan areas which are converging can be considered as one megacity (Folberth et al, 2015). As Molina and Molina (2014) mention, this definition is arbitrary, since in a certain metropolitan area not all residents live in a strictly urban settlement, or live outside of the city's formal boundaries. There is no commonly accepted definition as for where a city begins and where it ends; therefore, the definition of a megacity refers to a large agglomeration of people and their housing, employment, transportation and security needs.

The number and size of large cities and urban conglomerations has increased dramatically during the second half of the 20th century. In 1800, London was the only major city in the world, with a population of 1 million. Cities with a population of at least 1 million increased to three by the beginning of the twentieth century; today, there are 281. The average population of the 100 largest cities was 200,000 in 1800; this increased to 2.1 million by 1950, 5 million by 1990, and 7.7 million by 2002. In 1900, nine of the ten largest cities were in North America and Europe, whereas today only three (Los Angeles, New York, and Tokyo) are in the developed world. In 1950, New York and Tokyo were the only megacities. That number grew to four (Tokyo, New York, Shanghai, and Mexico City) by 1975 (Molina and Molina, 2014). According to the UN there were 19 megacities in 2007 and 28 in 2014, when in total 453 million people were residing in megacities. This number is expected to increase to 41 by the year 2030 (UN, 2007; UN, 2014).

2.2 Vulnerability of Large Cities to Climate Change

De Sherbinin et al (2007) define vulnerability as the degree to which a system or a unit is likely to experience harm due to exposure to perturbations or stress. It is usually identified in terms of three elements: system exposure to crises, stresses and shocks; inadequate system capacity to cope; and consequences and attendant risks of slow or poor system recovery.

Cities are especially vulnerable to the negative impacts of climate change (Stone, 2012:74; IPCC, 2014; De Sherbinin et al, 2007). Dodman & Satterthwaite (2008) summarize the possible impacts, as listed in table 1. EEA (2012) and Geneletti & Zardo (2016) group the possible impacts of climate change on cities into three categories: temperature related impacts, flood related impacts and water scarcity related impacts.

Table 1: Possible impacts of climate change on urban areas, adapted from Dodman and Satterthwaite (2008)

Change in climate		Possible impact on urban areas
Change in means	Temperature	Increased energy demands for heating/cooling Worsening air quality Exaggerated by UHI
	Precipitation	Increased risk of flooding Increased risk of landslides Distress migration from rural areas Interruption of food supply networks
	Sea-level rise	Coastal flooding Reduced income from agriculture and tourism Salinization of water sources
Change in extremes	Extreme rainfall	More intense flooding Higher risk of landslides Disruption to livelihood and city economies Damage to home and businesses
	Drought	Water shortages Higher food prices Disruption of hydro-electricity Distress migration from rural areas
Change in exposure	Heat or cold waves	Movements from stressed rural habitats
	Biological changes	Extended vector habitats

Due to their special characteristics, urban areas tend to have higher surface temperature than their natural or rural surroundings, in rates that can vary between 2-12 °C. This phenomenon is commonly characterized as the urban heat island effect (UHI) (Stone et al, 2012). The UHI aggravates the effect of increasing temperatures and extreme heatwaves on urban dwellers (Müller et al, 2014). Kleerekoper et al (2012) names seven causes for UHI: Absorption of short wave radiation from the sun in low albedo materials and trapping multiple reflections between buildings; air pollution in the urban atmosphere absorbs and re-emits long-wave radiation to the urban environment; obstruction of the sky by buildings results in decreased long-wave radiative heat loss from street canyons; anthropogenic heat is released by combustion processes, such as traffic, space heating and industries; increased heat storage by building materials with larger thermal admittance; decreased evapotranspiration due to impermeability of surfaces; reduction of wind speed in streets.

An additional risk factor common among large cities is being at low elevations on the coastline, due to sea level rise. Sea level rise and higher frequency of extreme weather events, such as tropical storms, increase the risk of flooding in these settlements (McGranahan et al, 2007). This risk is

aggravated in cities located in delta areas, where a river is connected to the sea (IPCC, 2007; Balica et al, 2012). As previously mentioned, the risk is even higher in low-income countries where infrastructure is less developed. More than 50% of the world's population resides on coastal or other low-elevation regions, and 65% of cities with a population of more than 5 million inhabitants also lie in these areas (McGranahan et al, 2007; Hunt & Watkiss, 2007). In addition, change in rainfall patterns might cause more frequent flooding, since the existing drainage systems may not be suitable for the increased amount of rainfall (Huq et al, 2007).

Freshwater sources in urban areas are limited, and with the growing population in cities, water shortages are becoming more and more frequent (McDonald et al, 2011). Climate change aggravates the potential for shortages due to changes in rainfall patterns, mainly a reduction in the amounts of rainwater in some areas, expected droughts, and salinization of groundwater sources due to sea level rise (Satterthwaite et al, 2007).

Although cities inhibit more than half of the world's population, they occupy only 2.8 percent of the world's land area (Dodman et al, 2013, p. 22). As urban areas consist of large amounts of the population in a high density, climate change poses an additional risk to human health by aggravating various illnesses. Heat stress can cause death among the elderly and those who suffer from a previous cardio-respiratory condition. A warmer climate effects the concentrations and distribution of air pollutants and the production of aeroallergens. Extreme weather events, besides causing direct damage, contribute to the spread of infectious diseases. Warmer climates reduce the development time of some mosquito and tick borne pathogens and increase their transmission potential to humans. Furthermore, irregular rainfall patterns can affect the availability and quality of water, while warmer climates increase the bacterial infection potential of water sources (Kovats & Akhtar, 2008).

Fast growing urban areas are particularly vulnerable to these adverse effects. Fast growing urban settlements in low income countries suffer from unplanned patterns of growth, the population residing in informal settlements, which results in high population density, as well as lack of green spaces and proper infrastructure (IPCC, 2014). Furthermore, the large number of people living in a relatively small area increases the scale of risk. This intensifies even more when it comes to low-income populations and marginalized populations with the least political influence (Satterthwaite et al, 2007; De Sherbinin et al, 2007).

2.3 Climate Change Adaptation at the Municipal Level

Response to climate change on the urban level began in the early 1990s, predominantly in North America and Europe (Bulkeley, 2010). In the 2000s, more and more efforts to tackle climate change on the city level were made, especially through international networks such as the covenant of mayors, or the C40 climate leadership group (Bulkeley, 2010; Kern & Alber, 2009; Hunt & Watkiss,

2011). These networks, together with mainstream development organizations such as UN Habitat or the World Bank, assisted in expanding these efforts to cities in the global south during the last decade (Bulkeley, 2010; Anguelovski & Carmin, 2011).

The IPCC defines climate change adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Planning for climate chance is, in most cases, focused on mitigation strategies, namely reduction of GHG emissions through different measures (Gil et al, 2007; Reckien et al, 2014; Füssel, 2007; Kern & Alber, 2009), since mitigation efforts have shorter time frames and measurable results - factors which are favorable for decision makers (Laukonnen et al, 2009). Yet in recent years more attention has been drawn in the direction of adaptive interventions, since some of the adverse effects of climate change are already significant (Geneletti & Zardo, 2016). In many cases, adaptation efforts at the local level, namely action plans, are made parallel to mitigation efforts (Laukonnen et al 2009; Reckein et al, 2014).

Another differentiation in planning adaptation and mitigation measures is the different levels of governance in which they are best applied (Laukonnen et al, 2009; Satterthwaite et al, 2007). Mitigation measures can be applied on different levels, yet major mitigation measures often involve large measures that require significant investment and correlate with obligations of nation states according to international agreements, thus most commonly planned on a national or international level. Mitigation actions on the local level are common as well, and play an important role in assisting nation states to achieve their emission reduction goals (Tang et al, 2010; Laukonnen et al, 2009). Adaptation measures can be planned on different governance levels (Kern & Alber, 2009), yet are most effectively applied at the local level, as they then most appropriately address the specific effects of climate change that occur (Stone et al, 2012; Laukonnen et al, 2009; Satterthwaite et al, 2007). Nevertheless, different studies have found that urban climate change action plans are still more focused on mitigation rather than adaptation (Reckein et al, 2014; Bulkeley, 2010; Füssel, 2007).

Jones et al (2012) differentiates between two different approaches towards adaptation: soft and hard. Soft approaches focus on information, policy, capacity building and institutional function, such as development of early warning systems for floods and droughts, climate-related insurance schemes, or educational activities that encourage capacity building among communities at risk. Hard approaches focus on implementing technological solutions or infrastructure-based interventions to cope with the adverse effects of climate change. Hard adaptation approaches can be further divided into gray infrastructure approach and green infrastructure approach (Jones et al, 2012; EEA, 2012).

Kern & Alber (2009) classify the forms of governing actions taken by cities in four categories: self-governing actions, which can be defined as the capacity of a local government to govern its own actions, for example by implementing adaptive measures in government buildings; governing through

enabling, defined as the enabling of partnerships with private entities and encouraging community engagement through positive incentives and persuasion; governing by provision, which is defined as delivering of particular forms of services and resources, for example by installing infrastructure or through financial policies; and lastly, governing by regulation, which is defined as the use of traditional forms of authority, such as legislation and the use of sanctions, or through implementing adaptation measures into binding urban planning processes.

The plans themselves can vary greatly in terms of content, form, style and level of detail (Wheeler, 2008; Geneletti & Zardo, 2016; Kern & Alber, 2009). Reckein et al (2014) explain that planning adaptation measures could be done through different kinds of documents: specific adaptation or mitigation plans that are either published by the city or a relevant city agency, a plan developed by a third-party organization and approved by the city, or sectoral plans which refer to one field of action, for example energy plans. Kern & Alber (2009) mention a similar division, but emphasize that in some cases, adaptation plans come in the form of a preparatory study which recommends further actions to be planned in the future. Wheeler (2008) differentiates between plans that develop policy for the public sector only, and plans that develop policies for the geographic area of which that government has jurisdiction.

Cities in low and middle income countries suffer from a lack of adaptive capacity, which hinders the efforts to deal with problems of climate vulnerability and climate change (Satterthwaite et al, 2007; Moser & Satterthwaite, 2010; Adger et al, 2003; Roberts et al, 2012). Roberts et al (2012) name several factors causing this adaptation deficit: the lack of proper gray infrastructure, such as drains, sewers and roads; the destruction of green infrastructure; and lack of capacity as a result of poverty, underdevelopment, poor governance and lack of skills. The last is also emphasized by Moser & Satterthwaite (2010), who argue that local governments are often unwilling to work with residents of informal settlements, which constitute a large part of urban dwellers.

One major obstacle in planning climate change adaptation on the municipal level is implementation (Wheeler, 2008; Satterthwaite et al, 2007), since it involves different actors and requires varying amounts of resources, time, skills and effort (Moser & Ekstrom, 2010). As climate change adaptation is a relatively new policy domain, it lacks the norms and institutions that create an established framework for such action (Anguelovski & Carmin, 2011). An additional constraint, especially in developing countries, is the dependency on international cooperation or aid in order to foster implementation of planned measures (Satterthwaite et al, 2007; Anguelovski & Carmin, 2011). Furthermore, implementation of adaptation actions at the local level could face additional difficulties under undemocratic governments, since it is harder for local governments to obtain support from the national government, and possibly such regimes would not consider the immediate needs of local communities, especially of the poor (Satterthwaite et al, 2007).

International organizations and city alliances play a key role in assisting local governments in developing climate change adaptation strategies (Zeppel, 2013). The strategy most commonly referred to is from the International Council for Local Environmental Initiatives (ICLEI) (Stone et al, 2012; Wheeler, 2008; Anguelovski & Carmin, 2011). ICLEI's climate change adaptation guidelines for municipalities (2010) contain a list of recommended data that should be considered for every adaptation action detailed in a municipal strategy or plan, in order to foster a successful implementation process:

- A responsible department in charge of the implementation of the action
- Other relevant departments that should be involved in the planning and/or implementation
- Timeline: is this action ongoing, immediate, future – when should it start and how long would it take to complete
- Costs: what the anticipated costs of the action are. This could be represented with symbols or words, and must not be an exact sum or a budget plan
- Funding: can this action be funded with an existing budget, future budget, through third-party funding etc.
- Target: what are your community's objectives and actions striving to accomplish within a defined timeframe?
- Indicators: what is the baseline information required to measure the effectiveness of the action against
- Pre-cursors to action: what steps need to be taken to enable the implementation of an action (research studies, establishing partnerships, etc.)
- Other factors important to consider, such as pre-planning needs, major sub-tasks, potential barriers

For the purpose of this research, this checklist was used as a guideline to evaluate the implementation process in the case studies analyzed (see discussion on research methodology on chapter 4.2).

3. Ecosystem Based Adaptation

3.1 Definition

Daily (1997, p. 3-4) defines ecosystem services as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage, timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products and their precursors". These services include: purification of air and water; mitigation of floods and droughts; detoxification and decomposition of wastes; generation and renewal of soil and soil fertility; pollination of crops and

natural vegetation; control of the vast majority of potential agricultural pests; dispersal of seeds and translocation of nutrients; maintenance of biodiversity, from which humanity has derived key elements of its agricultural, medicinal, and industrial enterprise; protection from the sun's harmful ultraviolet rays; partial stabilization of climate; moderation of temperature extremes and the force of winds and waves; support of diverse human cultures; providing of aesthetic beauty and intellectual stimulation that lift the human spirit.

In the case of the urban environment, it is possible to consider a city as a single ecosystem, or to see it as if it is composed of several individual ecosystems. When considering individual ecosystems within a city, those could be lawns, parks, street trees, urban forests, cultivated lands, wetlands, rivers, streams, lakes and seas (Bolund & Hunhammar, 1999). In different regions, different services are considered more important than others. For example, in rural areas food and resource production are more relevant than in cities, where regulating services such as temperature altering, or benefits related to recreation, are more relevant (Niemlä et al, 2010). It is increasingly recognized that ecosystem services can and should be incorporated into urban planning, and in planning towards climate change adaptation (Ahern et al, 2014; Wamsler et al, 2014).

Ecosystem-based Adaptation (EbA) is defined as "the use of biodiversity and ecosystem services as a part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change" (CBD, 2009). This approach shares attributes of both soft and hard adaptation approaches (Jones et al, 2012), and harnesses the capacity of nature to buffer human communities against the adverse impacts of climate change through the sustainable delivery of ecosystem services (Jones et al, 2012; Wamsler et al, 2014; Munang et al, 2013, Gill et al, 2007). As one of the possible elements of an overall adaptation strategy, EbA uses the sustainable management, conservation, and restoration of ecosystems to provide services that potentially reduce the exposure to climate change (CBD, 2009; Jones et al, 2012). It advocates mainstreaming of both ecosystem services and climate change adaptation to foster sustainable planning and to comprehensively address the impacts of climatic extremes and variability (Wamsler, 2015).

3.2 EbA Measures

Different measures can be considered as measures of ecosystem-based adaptation. Table 2 summarizes the measures relevant to urban areas, based on a list appearing in an EEA report (2012) and summarized by Geneletti and Zardo (2016), and revised using information appearing in Roberts et al (2012) and Gomez-Baggerhun and Barton (2013). The revisions to the original table were made because it focused on characteristics of European cities, while some EbA measures, for example measure G, could be seen as relevant for cities in other regions. Furthermore, it only refers to measures relevant for urban areas and their vulnerabilities, as discussed in chapter 2.2. Other EbA measures are described in the literature, for example by Neumann et al (2011), World Bank (2010),

Jones et al (2012) or Campbell et al (2009), among others. However, some of those are relevant for natural and rural areas and not for the urban context.

Table 2: EbA measures relevant for urban areas, adapted from Geneletti and Zardo (2016) after EEA (2012), and revised with information appearing in Roberts et al (2012) and Gomez-Baggerhun and Barton (2013)

CC Impact	Measure	Rationale	Potential Co-Benefits
Heat Stress	(A) Ensuring ventilation from cooler areas outside the city through waterway and green areas	If carefully designed, urban waterways and open green areas have the potential to create air circulation and provide downwind cooling effect	Reducing energy consumption
Heat Stress	(B) Promoting green walls and roofs	Vegetated roofs and facades improve the thermal comfort of buildings, particularly in hot and dry climate	Water retention Aesthetic benefits Recreational benefits
Heat Stress	(C) Maintaining or enhancing urban green	Green urban areas reduce air and surface temperature by providing shading and enhancing evapotranspiration. This cooling impact is reflected, to some extent, also in the building environment surrounding green areas	Increase permeability Water retention Protecting / enhancing biodiversity Aesthetic benefits Recreational benefits Carbon Sequestration Air purification Food production Noise Reduction
Floods	(D) Avoiding or reducing impervious surfaces	Interventions to reduce impervious surfaces in urban environments (e.g. porous paving; green parking lots; brownfield restoration) contribute to slow down water runoff and enhance water infiltration, reducing peak discharge and offering protection against extreme precipitation events	Allowing recharge of groundwater resources
Floods	(E) Re-naturalizing river systems and flood plains	Restoring river and flood-plain systems to a more natural state in order to create space for floodwater can support higher base flows, reducing flood risk. Restoration interventions include, for example, the establishment of backwaters and channel features and the creation of more natural bank profiles and meanders	Protecting / enhancing biodiversity Improving human health Recreational benefits Aesthetic benefits

Floods Water Scarcity	(F) Maintaining and managing urban green areas for flood retention and water storage	Vegetated areas reduce peak discharge, increase infiltration and induce the replenishment of groundwater. To enhance this, retention basins, swales, and wet detention systems can be designed into open spaces and urban parks	Allowing recharge of groundwater resources Improving human health Recreational benefits Aesthetic benefits
Floods	(G) Protecting and restoring marine/coastal ecosystems	In coastal cities, the coastal and marine environment provides an additional layer of protection against storm surges. Healthy coral reefs and coastal vegetation like mangroves for example	Carbon sequestration Protecting / enhancing biodiversity
Water Scarcity	(H) Promoting the use of vegetation adapted to the changing climate	Green space may exacerbate water scarcity in urban areas. To limit this problem, interventions can be directed at choosing the most appropriate plant species. For example, plant species that are drought resistant but still suitable as a part of the urban green space	Reducing maintenance costs Protecting / enhancing biodiversity
Water Scarcity	(I) Ensuring sustainable watering of green spaces	Harvesting rain water and redirecting them for watering of private or public green spaces	Reducing maintenance costs Flood mitigation

3.3 Incorporation into Urban Strategies

EbA can generate significant social, economic and cultural co-benefits, contribute to biodiversity conversion, and provide various environmental as well as societal benefits (CBD, 2009; Munang et al, 2013), with lower costs compared to traditional infrastructure-based approaches (Jones et al, 2012; Munang et al, 2013; Campbell et al, 2009), allowing high flexibility and creating opportunities for win-win situations, and contributes to a “no-regrets” approach while addressing climate change (Munang et al, 2013; Roberts et al, 2016). Thus, it is imperative to incorporate and mainstream EbA into decision making frameworks and planning processes (Munang et al, 2013; Geneletti & Zardo, 2016).

Even though it is promising, currently EbA is underused by policy makers (Munang et al, 2013). When applied, although it is discussed in the literature as a concept, in practice, measures that can be defined as EbA are usually taken independently, and not labelled as such (Wamsler et al, 2014). EbA measures are found in municipal climate change action plans, yet the term EbA as a concept is not commonly discussed in climate change action plans or other planning documents (Wamsler, 2015). In many cases, other terminology is used to describe such measures, for example “landscape-based adaptation” or “green and blue infrastructure” (Wamsler, 2015; Geneletti & Zardo, 2016).

In European cities, EbA measures are most commonly discussed in the context of heat-related impacts (Wamsler et al, 2014; Wamsler, 2015), possibly due to lack of awareness or sufficient knowledge regarding other possible benefits of those measures (Wamsler, 2015). It is also suggested that the lack of a generally accepted typology that would define EbA and include all past experience in applying these measures under an agreed set of terms would contribute to their inclusion in future planning efforts (Mercer et al, 2012). Furthermore, it is suggested that although co-benefits of EbA measures beyond climate change adaptation are clearly discussed in the academic literature, they are not yet explicit to policy makers, which hinders their incorporation on a wider scale (Geneletti & Zardo, 2016; Jones et al, 2012).

4. Research Methodology

4.1 Research Questions

Based on the information above, this thesis will attempt to answer the following four research questions:

RQ1: To what extent are ecosystem-based adaptation measures considered in climate change action plans of large cities?

The measures detailed in table 2 would be sought for in three different thematic components of the action plans: information, vision and actions. Further information on the different components are discussed in chapter 4.2.

RQ2: To what extent do the action plans provide a clear roadmap towards implementation of the planned EbA measures?

In many cases, the deadline set in the analyzed document for the completion of the implementation process is yet to come, and understanding of whether these measures have actually been implemented would be beyond the scope of this thesis. The relevant preconditions for implementation are those detailed in the ICLEI guidelines and are discussed in chapter 2.3.

RQ3: Are EbA measures discussed in the context of several benefits, and are opportunities for utilizing co-benefits and creating win-win solutions discussed?

Since many of the discussed adaptation measures can be multifunctional, we would check whether this potential for multiple benefits is discussed in the action plans. Multiple benefits of win-win situations could be addressing several environmental issues and also be serving other purposes (i.e. leisure). Possible co-benefits are detailed in table 2.

RQ4: What differences can be observed between different cities? Is it possible to categorize the action plans – if yes, according to which criteria?

In this part I will search for commonalities and differences between the different plans, and try to observe whether some characteristics of the analyzed documents or of the cities can be used as guiding criteria. For example, whether there are differences between cities in developed and developing countries, by socio-economic conditions of its population, pace of its growth etc. Characteristics regarding the documents themselves might also be considered.

4.2 Methodology

After defining ecosystem-based adaptation and explaining which measures are considered as such and are relevant to urban areas in table 2, the plans are divided into different forms. In order to give some order to the analysis, the content in the analyzed documents are to be divided into four thematic components, based on classifications made by Baker et al (2012) and Heidrich et al (2013):

1. *Information*, which consists of the base information, current conditions, climate data and predictions on which the action plan is based, as well as providing information for which solutions could be applied in the specific conditions discussed;

2. *Vision*, which consists of a long term vision on how the city would look once the plan is implemented, general directions and preferences in applying different possible solutions, and targets to be achieved;

3. *Actions*, which consists of the practical steps to be taken;

4. *Implementation*, which consists of a roadmap towards realization of the suggested measures, funding, legal measures, stakeholders' involvement etc.

Some of the plans do not contain all parts detailed above, and in some the chapters are organized in such a way that information that belongs to different parts according to this classification is presented together in one chapter. In case of the latter, the content relevant for each part according to the division and the categorization system presented later in this chapter will be analyzed separately. An explanation of how each plan is structured will be given in the beginning of the analysis.

The plans will be analyzed using a directed content analysis in order to find if and where ecosystem based adaptation measures, as previously defined, are included. In directed content analysis, concepts or categories are defined prior to the analysis using existing research, and used as a coding system. Later, these concepts are sought for within the analyzed text (Hsieh and Shannon, 2005). A directed content analysis was preferred over keyword based analysis since, as noted by Geneletti and Zardo (2016), the field of EbA is rather new and standardized terminology is yet to be established. The data collected from the action plans will be used to answer the RQ1-3. Each one of the case studies will be analyzed separately.

The information in components 1-3 will be used to answer RQ1, while the information supplied in the 4th component will be used to answer RQ2. In order to answer RQ1 with detail regarding the first three components, the following will be used as guiding questions:

Information: *Are EbA measures mentioned in the informative part of the action plan, in the context of tackling a specific climate change issue?*

Vision: *Are EbA measures discussed while declaring a vision and setting the goals and objectives of the action plan?*

Actions: *Are there specific EbA actions detailed in the action plan? To what extent are these measures detailed?*

The different components will be read and scored according to the scoring system detailed in table 3, similar to the scoring system used by Geneletti and Zardo (2016). RQ1 is regarding the information given in the first three sections: information, goals and actions, analyzed according to the three guiding questions. The information will be organized in a series of tables and graphs that will give an insight regarding the presence of measures in the different action plans of the cities chosen for analysis. Two different presentations will be done as the basis for further discussion of the results – one according to measures, as described in table 2, and the second according to city. An average score for each measure and each action plan will be calculated in three different ways: first, an average of the score whenever a measure was mentioned within a specific category as described above; second, an average score calculating all the times a measure was mentioned; and third, an average score calculating all case studies, as well as those which did not include that measure.

In order to answer RQ2, the preconditions for implementation will be considered for every action offered. Since it is beyond the scope of this paper to study which of the suggested measures are actually implemented, the actions will be evaluated according to the preconditions defined by ICLEI, which are presented in chapter 3.2. Where an action is merely based on regulation or legislation (governing by regulation, according to Kern & Adler, 2009), a time frame for a binding validity of that regulation would be considered sufficient. In some cases a specific action plan for a certain sector or action is published. In this case, the plan would be checked for these components, where possible. This analysis will take into account that not every measure is dependent on all of the preconditions in order to be implemented, especially in the case of governing by enabling or by regulation. In that case, only the relevant preconditions would be considered for the analysis. Also in this part, a similar grading system will be implemented. For the criteria of scoring for this section, see table 4.

Table 3: Scoring system to evaluate the inclusion of EbA measures in components 1-3 of the action plans, a revised version based on the system used by Geneletti & Zardo (2016)

Score	Information	Goals	Actions
0	No evidence	No evidence	No evidence
1	Generally acknowledges EbA measures	Generally mentions EbA-related objectives	Generally mentions actions related to the application of EbA measures
2	Acknowledges EbA measures in the context of a specific climate change issue	Includes specific and EbA-related objectives which are discussed in some detail regarding the desired application	Includes EbA measures in the actions and provides some details on their application, yet some specific information is left missing or unclear
3	Acknowledges EbA measures in the context of a specific climate change issue, and explains the climate change effect	Includes specific and quantifiable EbA-related objectives, and/or provides links to related planning and policy processes	Includes EbA-measures in the actions, provides information on their application and activities, including locally-specific details

When calculating the average score for the implementation efforts in the results, the total average would refer to the times an action was taken, rather than the total amount of times a measure was mentioned. Where an action was not detailed, implementation clauses are irrelevant. Calculating a score of 0 when no action led to any implementation clauses would not give a fair picture of the quality of implementation efforts, but rather deviate the results and lower the average score calculated for cities with fewer actions mentioned in their action plans.

Table 4: Scoring of the inclusion of preconditions for implementation, a revised version based on the system used by Geneletti and Zardo (2016)

0	Preconditions for implementation of the measures are not discussed
1	Some implementation clauses are mentioned, yet no clear path for implementation is set
2	Most of the preconditions are discussed, yet some questions remain open / a department specific action plan was released, yet it is not available
3	A detailed and comprehensive roadmap for implementation is presented, in which a significant number of preconditions for implementation are discussed, or the measure was incorporated into a binding planning process, such as a master plan

In order to answer RQ3, the EbA measures mentioned would be cross-checked to see if they are mentioned in the context of other benefits. The data would be presented in a table to give an overview of the different benefits attached to each measure. Furthermore, while analyzing the action plans it will be checked whether the solutions, while suggested, mention their potential to create win-win situations, as previously discussed. The way the action plan deals with the potential for win-win situations and co-benefits will be rated according to the following scoring system in table 5.

Later, in order to answer RQ4, a comparison of the data collected will be made that will show whether there are major differences, with regard to the answers of all previous research questions, between cities with different characteristics, as mentioned above. Where such differences are observed, a comprehensive table will be made to review these differences in the selected categories. The comparisons that yield relevant findings will be detailed in chapter 7.

Table 5: Scoring for the consideration of co-benefits of EbA measures in the action plans

0	Measures are discussed only in the context of achieving one purpose
1	Some co-benefits are mentioned briefly
2	Multiple benefits of several measures are discussed
3	The possibility of creating win-win situations or pursuing co-benefits is systematically discussed

4.3 Sample of Cities

The study will focus on large cities and metropolitan areas that have an official action plan for climate change which has been made available, is, at least partially, in English, and is comprehensive enough to allow for an analysis. Furthermore, cities from both developed and developing countries will be analyzed in order to allow a comparison between them. While choosing the right cases for the analysis, I wanted to ensure that the study would be focused on cities large enough to have the particular characteristics of a megacity or a city approaching that size, and that these cities are committed to taking action with regard to climate change. The number of inhabitants will not be the only criteria for selection, as membership in the C40 city alliance will also be required. This alliance defines itself as an “alliance of the world’s megacities” in its publications, and is enabling cooperation between its partners in the field of climate change adaptation and mitigation efforts. Since some of the cities in this alliance, such as Heidelberg and Basel, inhibit a very small number of people (less than 200,000), a minimum number of inhabitants was set at 5 million, to ensure that characteristics of a large metropole do exist in each of the chosen cities. The decision to go below the 10 million inhabitants barrier was due to the fact that fewer cities in the developed world are of that size. Therefore, in order to allow a comparison, a more inclusive definition was chosen.

Table 6: List of case study cities chosen for this thesis
Development status determined by UN (2014)
Source for number of inhabitants: Demographia (2017)

Continent	City (Country)	Developed / Developing	Inhabitants (metropolitan area, in millions)
Africa	Lagos (Nigeria)	Developing	13.3
Asia	Bangkok (Thailand)	Developing	15.6
	Delhi (India)	Developing	26.4
	Ho Chi Minh City (Vietnam)	Developing	10.3
	Hong Kong (China)	Developing	7.3
	Karachi (Pakistan)	Developing	23.5
	Kolkata (India)	Developing	14.9
	Mumbai (India)	Developing	22.8
	Singapore (Singapore)	Developed	5.8
	Tokyo (Japan)	Developed	37.9
Europe	London (England)	Developed	10.4
	Paris (France)	Developed	10.9
Latin America	Rio de Janeiro (Brazil)	Developing	11.6
North America	Chicago (USA)	Developed	9.1
	Los Angeles (USA)	Developed	15.5
	New York City (USA)	Developed	21.4
	Philadelphia (USA)	Developed	5.5
	Toronto (Canada)	Developed	6.5

First, all relevant cities which answer to the definition above were listed. A thorough internet search was conducted in order to locate relevant adaptation plans, where available to the public, and see which of them are written in English or have an English version. In some cases, a full English version was available, and in other cases only partial versions of different lengths. Only those with a sufficient level of detail were considered viable for analysis. A further criterion is cities with central municipal authorities. Metropolitan conglomerations which are not a single city, for example the German Rhine-Ruhr region or the Japanese Osaka-Kyoto region would thus be excluded. Plans relevant for analysis should be sufficiently detailed, thus longer plans would be preferred. Language will also be a factor, for practical reasons. I will only chose plans in languages which I can fluently read, thus English, German or Hebrew. Practically, this means focusing on documents in the English language. An additional factor is to pick cities with different conditions, in order to allow a valid comparison as an answer for RQ4: First, a similar number of cities from developed and developing countries. No large city in a country defined by the UN (2014) as a least developed country had a relevant planning document available for analysis. Second, cities from different countries, different continents and with different geographic, political and socio-economic conditions will also be sought. For example, at least some coastal and delta cities which are highly vulnerable would be preferred.

According to the conditions mentioned above, the cities chosen for analysis in this thesis are listed in table 6. The list of documents analyzed is found in chapter 9.2.

5. Case Studies

The text referring to the analysis of the case studies is structured as follows: first, an introductory paragraph will give some information regarding the document or documents found and analyzed – their name, the year they were published, their content and structure. Under the headline "Measures", EbA measures, as defined in table 2 and as found in the action plan will be described, with regard to the three components described in chapter 4.2, and with regard to implementation clauses. Under the headline "Co-benefits", the way the action plan deals with the topic of co-benefits and creating win-win situations would be referred to. In case there is any additional information worth mentioning, or general impressions from reading the plan that are relevant for the analysis, they will be mentioned at the end of the text, under the headline "Remarks".

5.1 Bangkok, Thailand

The plan was published in 2007 and set targets for the year 2012. It consists of 30 pages, and contains five major initiatives in different fields, focusing on mitigation but also covering adaptation measures. It is divided as follows: Introductory chapters (p. 5-10); Initiative 1 – expand mass transit and improve traffic system (p. 11-14); Initiative 2 – promote use of renewable energy (p. 15-18); Initiative 3 – improve building electricity consumption efficiency (p. 19-22); Initiative 4 – improve solid waste management and wastewater treatment efficiency (p. 23-26); Initiative 5 – expand park area (p. 27-29). Each initiative is then further divided into action plans (Bangkok, 2007, p. 4).

Measures:

(C) Maintaining or enhancing urban green

Information: Tree planting and park expansion is discussed in the context of CO_2 sequestration. Adaptation or other benefits are not discussed (Bangkok, 2007, p. 28).

Vision: The city aims for 87.75 million new trees to be planted by 2012 (Bangkok, 2007, p. 28).

Actions: 3 tree planting actions are mentioned. Planting 3 million trees in city owned territories by the end of 2012, launching a campaign to encourage tree planting on private lands in the city, and cooperating with neighboring provinces, encouraging them to increase tree cover in their territory (Bangkok, 2007, p. 28).

Implementation: 2012 was set as the deadline for implementing all mentioned actions. Targets according to the 2007 baseline are 3 million trees through direct planting, 24.45 million through

private actors and 60 million in neighboring regions through cooperation (Bangkok, 2007, p. 28). Costs, funding or responsible agencies were not mentioned.

5.2 Chicago, Illinois, United States

Chicago's climate change action plan was published in 2008 (referred to as Chicago 2008-1) and consists of 58 pages. It is divided into five different strategies: energy efficient buildings (p. 19-24), clean & renewable energy sources (p. 25-28), improved transportation options (p. 29-34), reduced waste & industrial pollution (p. 35-38), and adaptation (p. 39-52)(Chicago, 2008-1, p. 12). Each strategy is broken down into actions. The strategies are all aimed at targets to be achieved by 2020 (Chicago, 2008-1, p. 17-18). In addition, some of the measures suggested in this document refer to an additional document, Adding Green to Urban Design, also released in 2008 (Chicago, 2008-1, p. 43). Where this is the case, the Green Urban Design (GUD, referred to here as Chicago 2008-2) is analyzed as well.

Measures:

(B) Promoting green roofs / walls

Information: Even though it is listed as a mitigation measure intended to achieve energy efficiency, green roofs are discussed as natural cooling methods that would decrease energy consumption. It also explains the way green roofs function in reducing temperature of the buildings (Chicago, 2008-1, p. 22, 43).

Vision: The document has set a target of increasing the green roof cover to 6,000 by 2020, as a part of a retrofitting process aimed at creating a more sustainable built environment (Chicago, 2008-1, p. 22, 50).

Actions: This measure is discussed as part of a package of retrofitting efforts that are encouraged. These measures are directed both at commercial and residential buildings (Chicago, 2008-1, p. 20). In the GUD, action 3 deals with expanding the performance of green roofs through providing guidelines for successful application and anchoring them in binding guidelines and regulations (Chicago, 2008-2, p. 28, 44).

Implementation: The city has set a target of 6,000 green roofs by 2020, compared to 400 in 2008. As for funding, the action plan suggests encouraging private actors to implement these measures, mostly due to economic advantages of reducing energy consumption (Chicago, 2008, p. 20-22), yet also refers to support schemes provided by third-party organizations such as the Clinton Climate Initiative, Energy Savers program initiated by Preservation Compact, Cook County Community and Economic Development Association (Chicago, 2008-1, p. 20). In the GUD, a responsible agency is assigned –

Development Zone Plan – and implementation dates varies between October 2008 and December 2009 (Chicago, 2008-2, p. 44).

(C) Maintaining or enhancing urban green

Information: Although listed as a mitigation measure intended to achieve energy efficiency, tree planting is discussed as a natural cooling method that would decrease energy consumption (Chicago, 2008-1, p. 22). Furthermore, in the GUD, lack of vegetation is mentioned as one of the causes for increasing air temperatures within the city (Chicago, 2008-2, p. 12).

Vision: The action plan set a target of 1 million new trees planted by 2020, in addition to 4.1 million trees existing in 2008 (Chicago, 2008-1, p. 50; Chicago, 2008-2, p. 31).

Action: The GUD suggests several steps to achieve this goal: setting planting targets for landscape planners in charge of management of the city's open landscapes and starting an analysis to prioritize planting in under-canopied residential streets; and setting tree planting requirements in development approval procedures, which could be replaced with in-lieu fees (Chicago, 2008-2, p. 46).

Implementation: The agencies designated to promote these measures are the Department of Environment and the Bureau of Forestry. The funding should come from several sources: in-lieu fees charged when trees were not planted in new developments, and cooperation with non-profit organizations as well as private sponsors. The funds from both financing methods would be allocated to a city tree fund. Deadlines for these preliminary measures were set for 2009 (Chicago, 2008-2, p. 46).

(D) Avoiding / reducing impervious surfaces

Information: In the GUD it is stated that in 2008, 60% of the surfaces in the city were impervious to water, which leads to 98% of rainwater being directed into the sewer system. It is suggested that increasing the amount of porous surfaces using different measures would both reduce the risk of overflowing of the sewage system, thus reducing surface flooding, and would also reduce the risk of untreated sewage water flowing into the city (Chicago, 2008-2, p. 10) and the city's rivers and lakes (Chicago, 2008-2, p. 12).

Actions: Amendments were made to construction permit regulations and building backyard requirement documents in order to promote permeability by connecting it to sewer maintenance costs of the building (Chicago, 2008-2, p. 28). Additionally, "green paving" standards are to be developed (Chicago, 2008-2, p. 35).

Implementation: The GUD explains that the standards for the kind of paving and its application would be set according to the results of an ongoing study by the city department of transportation, set to conclude in June 2012 (Chicago, 2008-2, p. 50).

(F) Maintaining and managing urban green areas for flood retention and water storage

Information: The importance of green areas and street plants for retaining flood water as well as different ways in which this could be applied are discussed in the document (Chicago, 2008-1, p. 43).

Vision: It is stated that applying these solutions by 2020 is defined as a top priority, and they are a central part of the Green Urban Design document published later this year (Chicago, 2008-1, p. 43).

Action: The application of these measures is incorporated into a set of standards adopted for the development and maintenance of public landscapes and streets (Chicago, 2008-2, p. 27, 31). Furthermore, prototypes for integrating "green storm water infrastructure" into park planning are suggested (Chicago, 2008-2, p. 36).

Implementation: The research, development of prototypes and a cost-benefit analysis of applying these measures should be conducted by the department of water management and the metropolitan water reclamation district by June 2009, and later, based on the results, standards for applying the solutions in different parts of the city would be developed by the Department of Water Management, the City Department of Transportation, the Department for Environment and the Planning Department, not later than January 2011 (Chicago, 2008-2, p. 51).

(H) Promoting the use of vegetation adapted to the changing climate

Information: The GUD document mentions the global warming trends and explains that it might lead to a decline in the number of natural species that could keep on growing within the city. In particular it mentions the native white oak as a species that is at risk of not being suitable for the city's future climate (Chicago, 2008-2, p. 19).

Vision: The document states that a list of suitable plants that could thrive in an altered climate should be published, yet it doesn't set any provision or suggest any action for that list to be made (Chicago, 2008-1, p. 50).

(I) Ensuring sustainable watering of green spaces

Action: A rain-barrel incentive program was created in order to encourage residential buildings to install rainwater harvesting facilities and use them for irrigation (Chicago, 2008-2, p. 28, 45).

Co-benefits:

The issue of co-benefits is already addressed in the introduction of the document. In the first page of each strategy, there is a summary box detailing all other benefits that would be gained from applying it (Chicago, 2008, p. 13). When discussing tree planting, improving quality of life by creating attractive spaces for people to enjoy was mentioned as a co-benefit (Chicago, 2008-1, p. 22). While the first document, that contained a more general overview of measures, has discussed this issue in detail and in a systematic manner, the possibility to achieve co-benefits was not addressed.

Remarks:

The main strategy sets two general implementation clauses. It gives the city the role of building partnerships with the business sector in order to promote the implementation of the suggested measures, and establishing a monitoring committee with representation of businesses and community leaders which convenes annually in order to follow the implementation process and if needed, to amend the original goals set in the strategy (Chicago, 2008-1, p. 48). A similar case was observed in the case of funding of the measures, which relies on private rather than on public funds. All in all, the GUD sets a clear path for implementation through a set of regulatory clauses. To conclude, most of the actions taken by the city of Chicago are classified as governing by regulation, as defined by Kern & Adler (2009), a form of action which is not directly taken by city authorities, thus it is much harder to examine the quality of the implementation clauses.

5.3 Delhi, National Capital Territory of Delhi, India

Delhi's climate change agenda was released in 2009 and consists of 75 pages. The document consists of eight chapters. The 2nd chapter called Climate Change Agenda for Delhi (p. 5-19) covers the goals, objectives and priorities, while the 3rd (p. 21-35), 6th (p. 60-61) and 7th (p. 62-66) discuss actions. Implementation is discussed both in the 3rd chapter and in the 8th (p. 68-75). Chapters 4 and 7 provide data on the city's water bodies and waste management system (Delhi, 2009, p. 3). Basic information, as defined earlier, was not included in the plan. Delhi's master plan for 2021 that was published in 2007 contains an environmental chapter which contains some relevant measures (Delhi, 2007, p. i, iii). Those are reviewed here as well.

Measures:

(C) Maintaining and enhancing urban green

Vision: As part of the national plan called Mission for Green India, the city of New Delhi is committed to increasing the green cover in the city from 26 km^2 to 300 km^2 in a time frame of 10 years. That would consist 20% of the city's surface. An additional objective mentioned is to achieve 33% of green cover in a later time frame, which is not discussed (New Delhi, 2009, p. 30).

Actions: In order to achieve this goal, several actions were taken, as listed in Delhi, 2009, p. 30-31:

- Action 34: Establishing new 289 km^2 of forest cover in Delhi, especially around the Yamuna River and the Ridge area, where 6,000 ha are available for greening actions.
- Action 35: Creating 9 new city forests and "biodiversity parks", without explaining the function of those, to be established.
- Actions 36 and 39: Rejuvenating 14,000 colony parks and gardens and creating 1,000 new ones.

- Actions 41-43: Launching campaigns to encourage local communities to engage in greening efforts, by establishing herb gardens, colony gardens and school vegetable gardens.

Furthermore, in the master plan, a green belt consisting of vegetation fields, forestation actions and agriculture is planned on the border of the city with the national capital region surrounding it (Delhi, 2007, p. 97).

Implementation: For each of the actions mentioned above, additional implementation clauses are detailed in a tabular form - baseline data from 2009, target to be achieved by 2012 and the responsible departments (New Delhi, 2009, p. 30-31, p. 74). The actions were also incorporated in the city's master plan, and time frames for implementation are discussed, including mid-term goals in five year intervals until 2021 (Delhi, 2007, p. 207)

(D) Avoiding / reducing impervious surfaces

Information: The decrease in permeable surfaces is mentioned as a factor hindering ground water discharge (New Delhi, 2007, p. 90).

Actions: The master plan sets to introduce permeable paving and "soft" parking lots, without setting specific clauses or discussing the nature of the action in detail (Delhi, 2007, p. 91). In newly planned multipurpose grounds, 50% of the area should be planned as "soft" permeable parking (Delhi, 2007, p. 96). Furthermore, a regulation stipulating that new amusement parks planned should contain a maximum of 5% non-permeable land cover (Delhi, 2007, p. 97).

Implementation: The actions were incorporated in the city's master plan, and time frames for implementation are discussed, including mid-term goals in five year intervals until 2021 (Delhi, 2007, p. 207)

(E) Re-naturalizing river systems and flood plains

Information: The Yamuna River goes through 48 km within New Delhi and flood plains consist of 97 km^2, which are 7% the city's territory. The natural flow of the river is disturbed due to high rates of contamination, which hinders both the monsoon rainwater retention abilities and the ground water recharge abilities (Delhi, 2007, p. 94). The issue of ground water recharge is discussed in the environmental chapter of the master plan. The ground water potential has decreased from 428 million m^3 in 1983 to 292 million m^3 in 2003. The recharge of the aquifers is limited due to the decrease in permeable surfaces and runoff water being diverted to the sewage. Furthermore, since the city's surface water bodies are polluted, infiltration of fresh water to the aquifer is hindered (Delhi, 2007, p. 90-91).

Vision: The rejuvenation of the 48 km of the Yamuna River is discussed in the master plan. It aims to develop a systematic strategy for the re-naturalization of the river and would also include regulated flood plain reservoirs that would be used to ensure minimum flow during lean seasons (Delhi, 2007,

p. 94). Localities of these reservoirs or other specific re-naturalization actions were discussed neither in the master plan nor in the strategy.

Actions: Efforts to restore 620 water bodies within the city to their natural state are being made, in order to allow ground water recharge through them and sustain the existing drinking water sources. These efforts are not discussed in detail (Delhi, 2009, p. 33; Delhi, 2007, p. 91).

Implementation: Six agencies are named as responsible for implementation of the water body restoration efforts. Restoring all 620 water bodies was the declared goal, but criteria according to which they would be considered as restored were not discussed (Delhi, 2009, p. 33).

(F) Maintaining and managing green areas for flood retention

Action: In the master plan, regulations for implementing water retention into newly planned green areas are set. Each new multi-purpose open space planned should present clauses for rainwater harvesting, and every park planned should utilize 5-10% of its area for rainwater retention (Delhi, 2007, p. 96).

Implementation: The planning commitment regarding new park land has been incorporated into the city's master plan (Delhi, 2007, p. 96).

Co-benefits:

Different benefits of greening activities are discussed, when discussing specific measures. The benefits discussed are visual qualities, food production and being a carbon sink (Delhi, 2009, 30-31). When discussing the re-naturalizing of the river system, the benefits discussed are flood retention, ground water recharge, and aesthetic value of the riverfront (Delhi, 2007, p. 94).

Remarks:

Different EbA measures are discussed in both the master plan and the climate change action plan. Yet in some cases, these measures can only be interpreted as such, since there is not enough information regarding the reasoning behind the application of these measures, which effects they wish to tackle and what the expected benefits are. A good example for such a case is the greening effort, which discusses the side effects but not the positive effect on the UHI effect. Furthermore, some of the measures suggested are rather general, for example, when discussing the re-naturalization of the city's river system. No specific clauses tackling the river's pollution were mentioned, but just the need to recover it. A similar issue was observed when discussing the rejuvenation of the surface water bodies – no criteria for what would be considered "rejuvenated" were presented, and the actual clauses to do so were not detailed.

5.4 Ho Chi Minh City, Vietnam

Ho Chi Minh City's adaptation strategy was released in 2011 and consists of 126 pages (HCMC, 2011, p. 15-16). It was developed in cooperation with the Dutch city of Rotterdam through the Connecting Delta Cities network (HCMC, 2011, p. 7). This strategy is a part of a three-paper series, including an information atlas, which was published in the same year, and an action plan, supposed to cover the implementation procedures of the strategy (HCMC, 2011, p. 25). The action plan was not published.

The plan is divided into 7 chapters. Chapters 1-5 describe the basic conditions for the plan: the city characteristics, its ambitions, climate change scenarios, and the adaptive planning approach (information, p. 17-60). Chapter 6 sets six strategic directions for adaptation (goals, objectives, priorities, p. 61-89) and the last chapter breaks these strategic directions into actions in two pilot districts (actions, p. 91-114)(HCMC, 2011, p. 15-16). The strategy was made in coordination with the draft master plan for 2025 (HCMC, 2011, p. 39), yet reckons that successful adaptation measures need a longer time scale in order to ensure their application would not be regretted (HCMC, 2011, p. 49). Thus, the chapter explaining the strategic directions makes a distinction between short term measures that should be implemented by 2025, mid-term measures implemented by 2050, and long term measures implemented by 2100 (HCMC, 2011, p. 63).

The two districts chosen as pilot districts for a detailed climate-proof design are district 4, one of the most densely populated districts in the inner city (HCMC, 2011, p. 95) and Nha Be, a rural district in transition located close to the sea at low elevation (HCMC, 2011, p. 106). They were chosen as two different examples for districts affected both by the projected change in climatic conditions and by the relocation efforts of the city's harbor towards the south (HCMC, 2011, p. 93).

Measures:

(A) Ensuring ventilation from cooler areas

Vision: Intervention 6C recommends considering natural ventilation into the inner city while planning future development. It recommends taking into account the prevailing wind direction while planning high-rise buildings (HCMC, 2011, p. 89).

(B) Promoting green roofs and walls

Information: When discussing measures that would contribute to reducing heat stress, it is mentioned that green roofs and facades could contribute to natural cooling (HCMC, 2011, p. 89)

Vision: As part of intervention 6C, it is recommended to implement a green building code that would encourage green walls to be implemented on newly built buildings (HCMC, 2011, p. 89)

(C) Maintaining / enhancing urban green

Information: When discussing additional greening actions in later chapters, it is mentioned that these measures contribute to alleviating heat stress (HCMC, 2011, p. 89).

Vision: In the city's draft master plan for 2025, some measures in this direction are already in place – the protection of the 200 hectares of green zones existing in the inner city, and the development of an additional 250 hectares (HCMC, 2011, p. 40). It also explains that there is a need for coordination in maintaining these green spaces, and making sure they will not be lost or get fragmented due to other development needs (HCMC, 2011, p. 59).

Actions: The action plan suggests several actions to increase the city's green cover:

- Using vacated land to create new green areas, basing it on land becoming available from relocated factories (HCMC, 2011, p. 40) or old slums and social housing projects that are to be evicted (HCMC, 2011, p. 56). Waterfronts are also mentioned as areas that would be re-developed into green areas that would provide water storage as well as an "attractive environment for tourism and entertainment" (HCMC, 2011, p. 49).
- Intervention 6A: creating a city wide blue-green network of parks, tree lined streets, water fronts, fountains and water playgrounds that could contribute to alleviating heat stress, as well as storing flood water (HCMC, 2011, p. 89).
- Intervention 3B: developing and applying procedures to enforce standards according to which re-development projects would have to include parks, water areas and blue-green roofs (HCMC, 2011, p. 77).
- In addition, actions that should be incorporated into planning procedures at the ward level are suggested: tree lined avenues and neighborhood parks (HCMC, 2011, p. 91).

Implementation: increasing the city's green cover is included in the 2025 master plan published in 2010. The master plan is not available in English (HCMC, 2011, p. 40). No other implementation clauses were mentioned in the action plan.

(D) Avoiding / reducing impervious surfaces

Vision: Intervention 5B – it is stated that land permeability in the inner city should be increased, in order to stimulate groundwater recharge (HCMC, 2011, p. 86), without specific actions set to achieve that goal.

(E) Re-naturalizing river systems and flood plains

Information: It is further explained that only small sections of the city's water systems are in their natural state, and the natural state could be restored in order to increase water storage capacity

(HCMC, 2011, p. 40). Where the city's vulnerabilities are discussed, the over-development of the upstream watersheds is mentioned as a cause of the change in the river's runoff, increasing flooding frequency (HCMC, 2011, p. 47).

Vision: The need to re-naturalize the city's river systems is mentioned in the sub-chapter about the city's ambitions, mentioning that improving water quality in the city's river and canal system, as well as the natural drainage systems, is one of the goals for the coming century (HCMC, 2011, p. 30).

Actions: Intervention 2H – the protection of riparian zones, rivers and flood plains is mentioned briefly (HCMC, 2011, p. 73).

(F) Maintaining / managing green areas for flood retention

Information: The role of "blue and green spaces" in combating floods is mentioned in the introductory chapter, in the section about characteristics of Ho Chi Minh City. It is explained that the loss of these areas makes the city extremely vulnerable to water logging and floods (HCMC, 2011, p. 20). Furthermore, when discussing the planned blue-green network suggested as intervention 6A, the contribution of this network to flood water retention is also mentioned (HCMC, 2011, p. 89).

Action: Intervention 6A mentioned earlier under measure C is also relevant for this measure (HCMC, 2011, p. 89). Small parks developed at the ward level should include water storage elements (HCMC, 2011, p. 91).

(H) Promote the use of adapted vegetation

Actions: Intervention 4F - using salt resistant vegetation in flood prone areas due to the prospect of increased salinization of ground water sources. It suggests that newly planted trees and other kinds of vegetation in the city's parks that rely mostly on ground and surface water will be able to deal with high levels of salt in order to reduce the need for irrigation (HCMC, 2011, p. 82).

Co-benefits:

In the introductory chapters, the issue of co-benefits is mentioned several times. It is mentioned that the green areas that would be developed in the inner city will provide opportunities for synergism, as they would be used for other qualities besides water storage, such as leisure, providing shade and increasing water storage (HCMC, 2011, p. 49). It is explained that win-win measures are those which create both climate adaptation related benefits, as well as in other fields. Tracking these kinds of measures is regarded as a "key element" (HCMC, 2011, p. 60). This topic comes up again at the end of the sixth chapter, where strategic directions are discussed. There it is explained that "multifunctional solutions are often win-win solutions. Integrating climate change through multifunctional measures makes implementation of these measures more accepted, affordable and

more integrated into the future city" (HCMC, 2011, p. 91). At the end of each strategic direction, a table details which intervention is regarded as a win-win solution. Among them is intervention 6A, discussed earlier (HCMC, 2011, p. 89).

Remarks:

The action plan suggests many actions that could be taken, but it lacks specifics and the right conditions for implementation. Thus, in some parts, it was hard to tell which of the measures discussed are actions to be taken or general recommendations that might be considered in future plans, thus classifying them as a vision. Apart from one action that was also referred to the city's master plan, the other actions were not referring to any other document, nor including practical clauses or responsible agencies.

5.5 Hong Kong, China

Hong Kong's climate change agenda was published in 2010 and consists of 65 pages. It is not merely an adaptation strategy but rather entails both mitigation and adaptation measures. It is divided into five sections: Vision (p. 3-8), About Climate Change (p. 8-13), GHG Emissions in Hong Kong (p. 14-17), Joining Hands to Combat Climate Change (p. 18-23), and Hong Kong's Climate Change Strategy and Action Agenda (p. 24-55). The last section is divided into GHG reduction measures (p. 24-48) and Adaptation to Climate Change (p. 49-55)(Hong Kong, 2010, p. 2).

Measures:

(B) Promoting green roofs or walls

Information and Vision: One relevant measure was found in the mitigation section, where solutions for the reduction in energy consumption were mentioned. It mentions that it should promote the reduction of energy consumption in new buildings by "promoting wider adoption of green roofing, such that by 2020 all new commercial buildings will reduce their energy demand by 50% compared with new buildings in 2005" (Hong Kong, 2010, p. 27). Thus, mentioning green roofs in the context of cooling. No details regarding actions to promote this vision were mentioned.

Remarks:

The climate change agenda states it deals with both adaptation and mitigation, with a strong emphasis on mitigation actions. Green roofs were prioritized as a part of the mitigation efforts, but no practical actions were made to fulfill this vision. This was the only relevant action discussed in the agenda. The later sub-chapter on adaptation discusses vulnerabilities and possible actions, but does not suggest any relevant action that could be considered as ecosystem based.

5.6 Karachi, Pakistan

Karachi's adaptation strategy was released in 2012, and consists of 65 pages. The plan explains that due to the relatively low rates of GHG emissions in Pakistan (135th in the world in per capita emissions) the plan is to focus on adaptation measures rather than on mitigation (Karachi, 2012, p. 13). The plan focuses on identifying risks and prioritizing possible solutions rather than applying specific measures, thus laying a framework for the formation of a comprehensive strategy in the future (Karachi, 2012, p. 14). As mentioned in the plan, climate change adaptation is about promoting good development and good governance and bringing all relevant stakeholders under a common platform (Karachi, 2012, p. 62).

The plan is divided into three parts: Context for Adaptation (p. 15-18), Understanding the Impacts (p. 22-61) and Managing the Impacts (p. 62-65). Implementation is not discussed in this document. The chapter named "Understanding the Risks" is divided by possible risks, and then discusses the causes for the risk, different scenarios and the suggested relevant adaptation measures, while "Managing the Impacts" discusses measures relevant for Karachi (Karachi, 2012, p. 4). The adaptation strategy refers to another planning document, the Karachi strategic development plan for 2020, published in 2007, in which some of the measures discussed in the strategy are explained in detail (Karachi, 2012, p. 23). Where this is the case, the relevant information from the development plan is also analyzed.

Measures:

(B) Promoting green roofs and walls

Information: Green roofs are discussed in the context of increasing temperatures (Karachi, 2012, p. 50).

Vision: When discussing critical challenges the city is facing dealing with increasing temperatures, one of them is "to promote a green roof/rooftop garden program" (Karachi, 2012, p. 50). This need is mentioned again in the chapter "managing the impacts" (Karachi, 2012, p. 62), both without any further details.

(C) Maintaining and enhancing urban green

Information: The cooling effect of green spaces is discussed in the chapter on increasing temperatures (Karachi, 2012, p. 49) and the shrinking green cover of the city is mentioned as a critical challenge in this regard (Karachi, 2012, p. 49).

Vision: Increasing the green cover of the city is mentioned as a goal without detail (Karachi, 2012, p. 63).

(E) Re-naturalizing river systems and flood plains

Information: The plan discusses the role of the Malir and Lyari river basins as the main drainage capacity of Karachi, being responsible for 80 percent of the surface runoff. It explains that the natural flow and drainage capacity are disrupted due to irregular and illegal utilization practices, development actions on open areas on the riverside, and the creation of man-made disposal channels (Karachi, 2012, p. 23-24). Furthermore, a feasibility study conducted in 1990 could not locate appropriate floodplains that could be used as a viable flood risk zone (Karachi, 2012, p. 25).

(F) Maintaining and managing urban green for flood retention

Information: When discussing the risks of flooding, green spaces are mentioned as potential natural defenses (Karachi, 2012, p. 20), and later their relevant qualities, and the risk caused by their shrinkage is also discussed (Karachi, 2012, p. 31).

Vision: The need to design open green areas suitable for flood retention and thus spare other vulnerable areas from flooding is discussed, yet it is explained that currently this option is not utilized, since the city's green space is already shrinking (Karachi, 2012, p. 23). The need to increase the city's green cover in order to facilitate improved drainage is mentioned under "managing the impacts" (Karachi, 2012, 63-64).

Co-benefits:

Maintaining and enhancing urban green spaces is mentioned both in the context of adapting to the increasing temperatures and to the risks of floods. No other co-benefits were discussed.

Remarks:

Karachi's adaptation strategy identifies specific vulnerabilities and suggests possible ways to tackle them. Nevertheless, these visions presented are not translated into specific actions to be taken, nor do they present any implementation clauses. Nevertheless, the plan sets a vision that includes several EbA measures that might be used as a base for further planning and implementation in the future.

5.7 Kolkata, West Bengal, India

Kolkata's climate change roadmap was created with the support of the British government through UKaid organization (Kolkata, 2015, p. 5). It was released in 2015, and consists of 116 pages. It is divided into 5 sections: Background to the roadmap (p. 11-28); Strategic components (p. 29-72); Creating a green economy (p. 73-86); Spreading the message (p. 89-106); and Action summary (p. 107-115). The 8 strategic directions discussed handle aspects of both mitigation and adaptation: Climate-induced multi-disaster management plan; preparing of a strategy and action plan to address climate-induced public health hazards; energy efficiency; policy guidelines for grid-connected rooftop solar panels; strategy for climate-smart city mobility; policy for climate-smart built environment;

preparation of a climate-smart solid waste management strategy; and climate-smart land use strategies (Kolkata, 2015, p. 6-7). This document also relies on the action plan for climate change for the federal state of West Bengal published in 2011 that emphasizes some vulnerabilities of the Kolkata region, which are addressed in this document (Kolkata, 2015, p. 12).

Measures:

(B) Promoting green walls and roofs

Information: Rooftop gardens and green walls are discussed in the context of several benefits, among them reducing UHI effect and absorbing storm water (Kolkata, 2015, p. 56).

Vision: The document does not set specific goals with regard to green roofs and walls, but discusses the importance of integrating this concept into building guidelines, and explore ideas for incentive mechanisms in the future (Kolkata, 2015, p. 57).

Actions: The concept of green walls and rooftop gardens is a part of the green buildings concept. The document suggests several actions in order to promote the construction of greenery: First, develop clear and effective green building guidelines; second, create a green building unit that would support the implementation of the codes in private and commercial buildings; third, create a pilot area that would demonstrate how these guidelines should be successfully implemented (Kolkata, 2015, p. 58).

Implementation: The Kolkata Municipal Corporation was named as the leading agency that would implement these actions. The guidelines and units should be established within one year from the publication of this document, and the pilot area should be built within 5 years. As for funding options for later application of these actions, the document suggests developing a green building fund that would assist in raising awareness and other support, as well as encouraging banks to give better loan conditions for those who build according to the guidelines (Kolkata, 2015, p. 58).

(C) Maintaining or enhancing urban green

Information: The document mentions the reduction of green spaces as one of the causes for the intensification of the UHI effect. The percentile of green spaces has reduced from 25% in the early 1990s to 10% in 2015 (Kolkata, 2015, p. 20, 22). The cooling functions of green areas in comparison to build areas are explained later (Kolkata, 2015, p. 64).

Vision: The introductory chapter mentions the need to develop a landscape strategy that would include a hierarchy of green spaces to reduce UHI effect (Kolkata, 2015, p. 16). It also calls for the development of a greening strategy that would set specific objectives in order to increase green cover in Kolkata (Kolkata, 2015, p. 67).

Actions: Some of the actions that are suggested to be a part of this strategy are integrating open spaces into the city's streets, in traffic islands, tree planting in street facing boundaries and promoting

urban agriculture (Kolkata, 2015, p. 67). The specific application of these actions will be further discussed in the landscape strategy and the urban design strategy that are to be developed (Kolkata, 2015, p. 70). Furthermore, it suggests the establishment of an urban design unit that would be responsible for developing appropriate urban design strategies that would promote hierarchies for open and green spaces (Kolkata, 2015, p. 68). Community-based greening efforts and bottom-up urban agriculture schemes were a part of the Training for Green Livelihood scheme, an educational project that is intended to promote sustainable community behavior (Kolkata, 2015, p. 78). These community actions are also integrated into ward action plans (Kolkata, 2015, p. 92).

Implementation: The Kolkata Metropolitan Corporation is responsible for these actions. The mentioned strategies and the establishment of the urban design unit were defined as short term actions that would be completed within a time frame of two years (Kolkata, 2015, p. 70). The cost of the preparation of the landscape strategy and urban design strategy are estimated at 150 million INR (Kolkata, 2015, p. 85).

(E) Re-naturalizing river systems, water bodies and flood plains

Information: The document mentions the reduction and degradation of wetlands due to uncontrolled development as a factor increasing the risk of floods (Kolkata, 2015, p. 23). Furthermore, the degraded state of the rivers and backwaters is also mentioned as a major cause of floods (Kolkata, 2015, p. 32). Also, the banks of the Ganges are now mostly built, only 20% of them are in a natural form (Kolkata, 2015, p. 65).

Vision: The plan suggests the development of a trans-municipal basin approach for integrated riverfront development in order to safeguard natural drainage (Kolkata, 2015, p. 37). It discusses the need to establish specific action plans for river and waterbody restoration, as well as riverfront development. A set of actions that should be prioritized in these future strategic documents are mentioned – canal restoration; water body restoration using bio-engineering techniques including floating gardens; landscape designs for water bodies and their surroundings; restoring and linking inland waterways; stricter regulation on waste disposal; identification of heritage ponds and specific protection zones around them (Kolkata, 2015, p. 67).

Actions: It is also suggested that conservation and restoration projects of the city's water bodies would be included in the future green space strategy discussed earlier (Kolkata, 2015, p. 66). Furthermore, a riverfront redevelopment project that would include natural measures to defend from storm surges and assist in restoring the degraded waterbodies is recommended (Kolkata, 2015, p. 71).

Implementation: As mentioned earlier, the document recommends the development of particular strategies to promote the suggested solutions. Kolkata Metropolitan Corporation was named as the leading agency while Kolkata Metropolitan Development Authority was named as a secondary agency that should cooperate in this effort. A time frame of two years was defined for the

development of the strategies (Kolkata, 2015, p. 70). The cost of the preparation of the riverfront master plan is estimated at 500 million INR (Kolkata, 2015, p. 85).

General implementation clauses: 6 different funding sources are discussed in the document. Where the promotion of environmental solutions would require allocation of substantial funds, funds would be allocated from state government, from national agencies and initiatives, as well as international funds, institutional funds and private donors. Relevant funding sources are listed in a specific sub-chapter (Kolkata, 2015, p. 79-80).

Co-benefits:

When discussing the importance of green spaces to reduce the UHI effect, the other benefits mentioned are carbon sequestration and recreational value (Kolkata, 2015, p. 20). It also discusses the benefit to human health as a result of river and riverfront rehabilitation, as a clean river environment would reduce the risk of vector borne diseases (Kolkata, 2015, p. 39). Furthermore, riverfront development could contribute to recreation and promote tourism (Kolkata, 2015, p. 71). Green walls and rooftop gardens are mentioned, besides their benefits to adaptation, in the context of contributing to cleaner air, reducing energy consumption, their food production potential and their aesthetic benefits (Kolkata, 2015, p. 56).

Remarks:

The document goes into great detail for actions that can and should be implemented based on the challenging conditions existing in Kolkata. Nevertheless, the implementation of many of the measures is dependent on the development of a sector-specific strategy or action plan. Since the document is rather recent, these documents were not prepared up to this point, yet the conditions to allow a successful development of these documents are presented. Furthermore, even though the plan as itself does not create the optimal conditions for EbA measures to be conducted and implemented, it lays a well-established foundation for further planning efforts to be made, as well as providing all preconditions for the conduction of these efforts. Thus, filling the criteria for a maximal score on implementation in many of the cases (see table 8).

5.8 Lagos, Nigeria

Lagos' climate change policy document was published in 2012 and consists of 49 pages. It is divided into 5 chapters: Introduction (p. 1-5); Goals and Objectives (6-7); Policy Priorities (p. 8-29) - this chapter is divided into two subchapters – Adaptation (p. 8-19) and Mitigation (p. 20-29); Crosscutting Issues (p. 30-34); and Implementation and Resource Mobilization Plan (35-37) (Lagos, 2012, p. 7). This plan is referring to the federal state of Lagos, the smallest federal state in Nigeria, which consists mostly of the Lagos metropolitan area.

Measures:

(C) Maintaining or enhancing urban green

Vision: the document sets an objective to "promote the conservation and sustainable consumption of forests and other natural resources as a part of ecosystem based adaptation" (Lagos, 2012, p. 17).

Actions: The plan suggests starting afforestation actions focused on fast maturing species, as well as protective measures such as fencing, designating protected forest areas and raising awareness among different stakeholders in order to prevent over-consumption of urban forest resources (Lagos, 2012, p. 17). Other suggested measures are the introduction of urban agriculture practices (Lagos, 2012, p. 16), the replacement of vanishing forests within the city with parks and community gardens (Lagos, 2012, p. 16) and the establishment of community-based forest management schemes is also suggested (Lagos, 2012, p. 29).

(G) Protecting and restoring marine/coastal ecosystems

Information: When discussing the vulnerabilities of the coastal and marine ecosystem to climate change, some of the adaptation-related benefits are discussed – coral reefs and mangroves buffer the coastline against storm surges and thus reduce flood risks. Further benefits such as mangroves preventing coastal land erosion and food production in wetlands are also discussed (Lagos, 2012, p. 12).

Vision: The document sets as an objective to "enhance the adaptive capacity and resilience of the coastal and marine ecosystems, coastal communities and infrastructure against the adverse impacts of climate change as part of ecosystem-based adaptation" (Lagos. 2012, p. 13).

Actions: The plan calls for research in order to identify low-cost solutions to preserve the coastal and marine environment. It also calls to generate data regarding geomorphology, topography, land use, ownership, economic and cultural assets in these areas in order to promote an integrated coastal zone management involving all relevant stakeholders. In addition, it suggests defining buffer zones in which further developments in coastal areas would not be allowed (Lagos, 2012, p.13). It also suggests mangrove replanting efforts in degraded areas (Lagos, 2012, p. 14).

Implementation: The document does not specify implementation clauses for each measure, rather it discusses implementation of the strategy as a whole. The ministry of environment of the Lagos state is named as the head agency that should lead the efforts of implementation, and create the relevant partnerships with other agencies and private stakeholders (Lagos, 2012, p. 35). Financing the implementation of the strategy would be based both on state money and funding from international actors, such as climate change funds and through the Kyoto protocol's clean development mechanism (Lagos, 2012, p. 36).

(H) Promoting the use of vegetation adapted to the changing climate

Information: Since Lagos' food security is mostly dependent on local agriculture, a major risk factor is the fact that some of the commonly cultivated crops are dependent on stable amounts of rainfall (Lagos, 2012, p. 14).

Actions: The document suggests introducing salt-resistant flora and fauna in coastal areas to ensure the livelihood of communities dependent on them (Lagos, 2012, p. 14). It suggests replacing some of the crops cultivated to heat and drought resistant species in order to ensure food security (Lagos, 2012, p. 15). Furthermore, it suggests focusing reforestation measures using adapted tree species to ensure their survival during drought (Lagos, 2012, p. 29).

Co-benefits:

Both forests and mangroves are discussed in the context of carbon sequestration (Lagos, 2012, p. 27). Preservation of wetlands, mangroves and coral reefs are mentioned in the context of ensuring livelihood through providing the right environment for fish to thrive and thus ensuring food security, and through providing natural resources, and in the context of protecting biodiversity (Lagos, 2012, 11-12). Urban forests are mentioned in the context of carbon sequestration, protecting biodiversity and providing wood, but not in the context of cooling (Lagos, 2012, p. 16, 26).

5.9 London, United Kingdom

London's action plan was published in 2011 and consists of 126 pages. It is divided into four main chapters: Understanding the Climate of the Future (p. 23-36); Understanding and Managing the Impacts (p. 37-80); Assessing the Impacts on Cross-cutting Issues (p. 81-110); and Implementing the Strategy (p. 111-117). The 2nd and 3rd chapters first set policy goals and then break these down into specific actions. The first two chapters have a further sub-division according to categories of climate change impacts – flooding, drought and overheating. The 3rd chapter is divided into sections dealing with health, London's environment, London's economy and infrastructure (London, 2011, p. 4). The chapter on implementation is presented in a tabular form in which the responsibilities of each action detailed previously are assigned to a responsible agency (London, 2011, p. 112). In addition, a chapter titled "London's response to climate change" is a part of the latest master plan published in March 2016. Some of the actions discussed in the adaptation strategy are further discussed or amended in the master plan. Two sector-specific documents were referred to as well - the London River Action Plan (2009) and the All London green grid planning guidance (2012).

Measures:

(A) Ensuring ventilation from cooler areas

Vision: It is suggested that the London Green Grid, discussed later on under measures C and F, will take into account the prevailing easterly winds. Therefore, by focusing the greening efforts in East

London, lower air temperatures there will allow cooler wind to reduce temperatures in the city center (London, 2011, p. 73).

Actions: It is also suggested that breeze pathways would be incorporated while planning new development projects (London, 2011, p. 73).

(B) Promoting green roofs and walls

Information: The importance of green roofs as part of the greening measures is mentioned several times in the context of adapting to increasing temperatures. When discussing adapting individual buildings, green roofs and walls are named as one of five possible contributions to reduce the UHI effect (London, 2011, p. 75). In the sustainable design and construction guidelines, it is regarded as the most applicable measure in densely developed areas of the city (London, 2014, p. 79).

Vision: Policy 5.9 in The London Plan dictates a cooling hierarchy to be taken into account in future development projects. Reducing the amount of heat entering the building, by several measures, among them green roofs and walls, is placed second out of six measures in the hierarchy (London, 2016, p. 195). Action 5.6 in the section dealing with the UHI effect calls for the delivery of 100,000 m^2 of green roofs by 2012, comparing this with the 2008 baseline (London, 2011, p. 66).

Actions: In order to achieve this, major new developments would be required to include a green roof, where it is technically feasible (London, 2011, p. 74; London, 2016, p. 198) and the mayor will further define additional places where green roofs should be installed (London, 2011, p. 75).

Implementation: The goal, deadline and baseline data are defined while describing the action. Furthermore, the Greater London Authority is named as the leasing implementing agency, while the boroughs, private sector and voluntary sector are named as implementation partners (London, 2011, p. 113). Information regarding specific precursors to action, as well as costs, was not included.

(C) Maintaining or enhancing urban green

Information: in the context of overheating, increasing green cover is mentioned as a measure that would reduce the effect of the UHI effect (London, 2011, p. 34). It is explained that the proportion of green land cover is the key factor in determining the intensity of the UHI effect (London, 2011, p. 73). A study by Gil et al (2007), conducted in Manchester, found that increasing the urban green space by 10% could result in a decrease of 3-4 degrees centigrade in the urban environment (London, 2016, p. 198).

Vision: The concept of "greening London" takes a major part in the plan and is discussed extensively. Policy 2.18 in The London Plan discusses the idea of creating a multifunctional network of green and open spaces (London, 2016, p. 81-83). In the strategy, it is first mentioned in the preface as one of 3 pillars of adaptation, alongside retrofitting London and clean air for London. It aims to establish an interlinked, multi-functional network of open green spaces to be established by 2025 through two

different programs: RE:LEAF and London Green Grid (London, 2011, p. 7-8). The details of this vision are later explained (London, 2011, p. 90-95). In the chapter on overheating, under the policy vision, it is mentioned that "the mayor will work with partners to reduce and manage the impact of hot weather on London through … managing rising temperatures by increasing the amount of green space and vegetation in the city" (London, 2011, p. 66). In the sub-chapter about dealing with the risk of rising temperatures, several actions involving urban greening are mentioned in London, 2011, p. 88-91:

- Action 5.2: conducting a feasibility study on London's microclimate and the impacts of urban green on it.
- Action 5.3: enhance the city's green cover by 1,000 ha until 2012
- Action 5.4: increasing the green cover in central London in 5% by 2030 and in further 5% by 2050;
- Action 5.5: increasing the city's tree cover in 5% by 2025.

Actions: In order to achieve the greening objectives in a well-planned way and utilizing all possible benefits from them, a city-wide program called All London Green Grid was launched (London, 2011, p. 88, 91). The commitment mentioned in action 5.4 is also named as policy 5.10 in The London Plan. Furthermore, an additional target of 2 million new trees to be planted by the city until 2025 is mentioned (London, 2016, p. 197). It is also suggested that "the mayor will work with the boroughs and developers to identify UHI zones, integrate these into the map of the London Green Grid, and encourage the boroughs to act according to these findings in order to enhance the green cover in these areas" (London, 2011, p. 74). A map of the zones located appears on The London Plan (2016, p. 198).

Implementation: The timeline, indicators and targets were detailed in the action and presented in the last paragraph. As pre-cursors for action, two research projects called LUCID and BRIDGE were launched, to find out the optimal rate of green areas in the city, and the relation between greening measures to other adaptation activities (London, 2011, p. 74-75). The Great London Administration was named as the executing agency, and the boroughs and the private sector named as secondary actors (London, 2011, p. 113). In the All London Green Grid guideline, specific regulations for new development projects are discussed (London, 2012, p. 37), as well as revenue funding through mechanisms such as a Community Infrastructure Levy (London, 2012, p. 37). Guidelines are set for integration of the decisions at the borough level (London, 2012, p. 19) and the interrelation between these measures and other planning processes, such as the adaptation strategy and the London plan is discussed. As for increasing tree cover, The city has funded the planting of 10,000 new trees between 2009 and 2012, and launched a campaign called RE:LEAF in order to keep increasing the tree cover in the coming years (London, 2011, p. 95).

(D) Avoiding or reducing impervious surfaces

Vision: The document addresses the issue of permeability in private gardens, and sets to tackle this issue without setting any specific targets (London, 2011, p. 52). Furthermore, policy 5.13 in The London Plan dictates a sustainable drainage hierarchy to be used as a guideline for other planning measures, in which using porous surfaces is ranked second out of seven (London, 2016, p. 201).

Actions: Two actions are mentioned in order to increase permeability – working with the environment agency and Thames Water to launch pilot projects that would demonstrate permeability, and putting a policy in place that would require planning permission from house owners for impervious paving of a territory larger than 5 m^2 (London, 2011, p. 52).

Implementation: The Great London Administration was named as the leading agency, while Thames Water and the Environmental Agency are named as the secondary actors. Summer 2013 was set as the delivery time for the pilot projects (London, 2011, p. 113). The supporting policy was already put in place (London, 2011, p. 52), yet the details of the pilot projects, their costs and funding options were not discussed.

(E) Re-naturalizing river systems

Vision: Re-naturalizing 15km of London's rivers is set as a vision for 2015 and named action 7.1 (London, 2011, p. 87)

Actions: A separate program was launched to support restoration projects, named the London Rivers Action Plan (London, 2011, p. 93). In this program, over 60 restoration projects are supported (LRAP, 2009, p. 14). Action 7.3 suggests freeing London's rivers from concrete culverts and allowing natural processes to occur, creating flood plains and providing adjacent areas of habitat for refuge (London, 2011, p. 93). Additionally, it refers to The London Plan, the city's masterplan, where suitable areas for these measures are named (London, 2011, p. 95).

Implementation: The goal of restoring 15 km of the city's river system compared to the 2009 baseline was set for 2015 (London, 2011, p. 87). In the London River Action Plan, the specific actions to be conducted, potential partnerships, costs, possible funding options and additional implementation information of every project is presented (London, 2009, p. 12).

(F) Maintaining and managing urban green areas for flood retention and water storage

Information: When discussing the risk of flooding, the importance of urban green areas is mentioned, as well as the need to utilize parkland and sport fields to retain flood water (London, 2011, p. 30).

Vision: When discussing floods, it is mentioned that the mayor would work with other agencies and the boroughs to promote "an intensive urban greening and retrofitting pilot project to manage surface water risk" (London, 2011, p. 38).

Actions and Implementation: The greening efforts are discussed as a whole, see details under action (C).

(H) Promoting the use of vegetation adapted to the changing climate

Action: The selection of tree species adapted to the changing climate is promoted through the London Tree and Woodland Framework. Furthermore, the Royal Horticultural Society in cooperation with the forestry commission has produced a database of tree species and their particular climate sensitivities (London, 2011, p. 95).

Co-Benefits:

The potential multi-functionality of green spaces is mentioned several times throughout the document (London, 2011, p. 19, 40). In the chapter on London's environment, it is explained that the city's green spaces "perform a range of functions known as ecosystem services that improve the quality of life in London". These effects were discussed and presented in a table, which appears below.

Table 7: "Ecosystem Services Provided by Green Infrastructure", as discussed in London's adaptation strategy (London, 2011, p. 90)

Ecosystem service	Green roofs/walls	Street trees	Wetlands	River Corridors	Woodlands	Grasslands
Reduce Flood risk	XX	X	XXX	XXX	XX	XX
Offset urban heat island	XX	XX	XX	XX	XXX	X
Reduce energy demand	XX	XX				X
Reduce noise/air pollution		XX			XX	
Support biodiversity	XX	X	XXX	XXX	XXX	XXX
Recreation/leisure	X		X	XX	XXX	XXX

In addition, when discussing the green roof policy, seven potential benefits are mentioned: adapting to climate change in aiding cooling, sustainable urban drainage, mitigation of climate change in aiding energy efficiency, enhancing biodiversity, accessible roof space, improvements to appearance and resilience of the building, and growing food (London, 2016, p. 198). When discussing river restoration, it is suggested that removing concrete coverage from river banks will contribute to enhancing biodiversity, in addition to the climate change adaptation functions.

Remarks:

London's climate change adaptation strategy is a comprehensive document, and different EbA measures are regarded in it. Many of the measures suggested are incorporated into other planning instruments, such as The London Plan, or other, sector specific plans. In many cases a clear path towards implementation is presented. Nevertheless, in cases where implementation depends on involvement of other, non-governmental actors, the actions taken in order to implement a measure are

not always clear. Costs of the suggested actions, as well as funding mechanisms, are often not mentioned.

5.10 Los Angeles, California, United States

Los Angeles' environmental plan was published in 2015 and consists of 108 pages. It discusses climate change issues among other environmental issues. It states that a comprehensive climate change adaptation strategy should be developed by 2017 (Los Angeles, 2015, p. 70). The document is divided into three topical parts: Environment (p. 16-47) which covers topics such as water, solar energy, energy efficient buildings, carbon and climate leadership, and waste; Economy (p. 48-73) which covers topics such as housing and development, mobility and transit, prosperity and green jobs, and preparedness and resilience; and Equity (p. 74-97) which covers topics such as air quality, environmental justice, urban ecosystem and livable neighborhoods (Los Angeles, 2015, p. 3).

Measures:

(C) Maintaining or enhancing urban green

Information: The importance of city trees in tackling the effects of the UHI are briefly mentioned (Los Angeles, 2015, p. 71)

Vision: Adding additional trees within the city is set as a priority, without discussing in detail how to achieve it (Los Angeles, 2015, p. 71). It suggests increasing the number and spread of parks in the city so that 75% of the city's residents would live within ½ mile from a park by 2035. Furthermore, it suggests increasing urban agriculture sites by 50% by 2035 (Los Angeles, 2015, p. 87). It also calls to expand the number of green streets and green infrastructure within the city (Los Angeles, 2015, p. 91).

Actions: The documents details eight restoration reaches that would be initiated, plus 32 miles of greened river access to be created by 2025, and also discusses passing suitable legislation to support the development of urban gardening schemes, as well as promote investment in tree planting (Los Angeles, 2015, p. 90). Furthermore, the city has launched a project called "50 parks LA initiative", which works alongside other agencies and NGOs to increase the city's park cover (Los Angeles, 2015, p. 91).

Implementation: The document suggests amending the Quimby and Finn Fee schemes in order to gain more funding and accelerate the park expansion process (Los Angeles, 2015, p. 91).

(D) Avoiding or reducing impervious surfaces

Vision: The plan sets to expand the use of permeable paving in large infrastructure projects (Los Angeles, 2015, p. 21).

(E) Re-naturalizing river systems, water bodies and flood plains

Vision: The plan aims to restore at least 11 miles of the LA river (Los Angeles, 2015, p. 91).

Actions: The plan suggests updating the watershed protection policies in order to enhance stream protection (Los Angeles, 2015, p. 91).

(F) Maintaining and managing urban green areas for flood retention and water storage

Information: It discusses allowing captured storm water to be used as groundwater in order to minimize possible effects of predictable future droughts (Los Angeles, 2015, p. 16).

Vision: The plan calls to expand the number of green infrastructure sites and green streets in order to capture more storm water, without going into detail (Los Angeles, 2015, p. 21).

Actions: A clean-up process in the San Fernando groundwater basin had begun and was set to be finalized by 2017 (Los Angeles, 2015, p. 17).

Implementation: The city is currently funding the basin clean-up process, but it mentions the need to also develop a watershed management plan and to secure sufficient funding to operate it (Los Angeles, 2015, p. 20).

Co-benefits:

Possible positive side effects of cleaning and capturing storm water are reducing possible pollution of coastal water and thus reducing harm to marine ecosystems (Los Angeles, 2015, p. 17).

5.11 Mumbai, Maharashtra, India

The city of Mumbai doesn't have a specific climate change action plan. While searching for relevant documents for analysis, I found that in India climate change action plans are normally made on the federal state level. On the action plan of the state of Maharashtra, which was released in 2014, there is a specific chapter about climate change adaptation in Mumbai, the biggest city in this state (p. 269-286) (Maharashtra, 2014, p. vi). In September 2016, a master plan for the next 20 years was published. The measures mentioned in the action plan will be looked for there as well.

Measures:

(C) Maintaining or enhancing urban green

Information: Protecting forested areas around catchments is discussed both in the context of allowing recharge of ground water and improving ground water quality (Maharashtra, 2014, p. 269).

Vision: Increasing tree cover in the region was set as a goal for the next 5 years, without discussing specific actions to achieve it (Maharashtra, 2014, p. 285).

Action: In the masterplan, some of the city's green areas are designated for afforestation efforts. In addition, it identifies near-closure landfill sites and designates them to be converted to open green areas. It is also suggested to connect these areas in order to create a green network, through greening of river corridors and creating greenways along main roads (Mumbai, 2016, p. 129-131).

Implementation: Designation of the land was made through the master plan, and the discussed changes are to be gradually implemented by 2026. The costs are calculated as follows: 70 million INR for afforestation efforts, 10 billion INR for park development and 4.5 billion INR for river bank greening. A prioritization of the measures was set (Mumbai, 2016, p. 135).

(D) Avoiding or reducing impervious surfaces

Information: The issue of water permeability is addressed in the first paragraph of the chapter, explaining that until today scant attention was given to increasing infiltration of rain water in order to increase availability and quality of ground water (Maharashtra, 2014, p. 269). It also discusses the prevention of water logging in low lying areas as a co-benefit (Maharashtra, 2014, p. 284).

Action: The document aims to use porous asphalt in redevelopment actions made in the Mumbai Metropolitan Area. It does not detail where exactly, or on what scale, this measure would be applied (Maharashtra, 2014, p. 284). It also calls for the development of regulations that would promote the implementation of porous surfaces of different kinds at the local level (Maharashtra, 2014, p. 285).

Implementation: This action is defined as long term, to be implemented within 3-5 years. 3 departments were named as implementing agencies – Storm Water Drainage Department, Rainwater Harvesting Department, and the Public Works Department (Maharashtra, 2014, p. 284). Funding and quantifiable goals were not discussed.

Co-benefits:

Porous surfaces were discussed both in the context of ground water recharge and of flood water retention (Maharashtra, 2014, p. 269, 284). Increasing tree cover in catchment areas was discussed both in the context of ground water recharge and filtration, while preventing soil erosion was discussed as a co-benefit (Maharashtra, 2014, p. 285).

5.12 New York City, New York, United States

New York City has three relevant documents to be analyzed. The main strategy, A Greener, Greater New York was released in 2007 and it consists of 158 pages. It is divided into topical chapters on land (p. 16-51), water (52-71), transportation (p. 72-99), energy (p. 100-117), air (p. 118-131) and climate change (132-141) (NYC, 2007, p. 2). The most recent climate change related document was published in 2013 and consists of 445 pages. It was published as a response to hurricane Sandy and

functions as a response strategy (NYC, 2013, p. 1). It is divided into five main chapters: Introduction (p. 1-36); Citywide Infrastructure and the Built Environment (p. 37-234); Community Building and Resiliency Plans (p. 235-398); Funding (p. 399-406); and Implementation (p. 407-415) (NYC, 2013, p. vii). Both documents were analyzed. In addition, a sector specific document dealing with the city's waterfronts was published in 2011 which details site specific actions that were discussed in the 2007 document in detail. Where referred to, these are brought here as well.

Measures:

(B) Promoting green walls and roofs

Information: Implementing green roofs is discussed in two contexts – of retaining rain water and cooling the air. A sketch illustrating the mechanism of operation of a green roof is also included (NYC, 2007, p. 60-61).

Actions: three pilot projects, one on a residential building and two on commercial buildings were designed by the Best Management Practice agency, and will be used to gain data on how effective green roofs are in the long run. Additionally, the city is offering an incentive program that guarantees 35% of the costs of installing a green roof will be returned as tax abatements (NYC, 2007, p. 61).

Implementation: The Best Management Practice agency was named as the implementing agency, and a sum of 100,000 USD for the design and 1.3 million USD for installation were allocated for each pilot project. The incentive program is in place, and started at the beginning of 2007. No targets or time frames were discussed (NYC, 2007, p. 61).

(C) Maintaining or enhancing urban green

Information: Tree planting is mentioned in different chapters and discussed in the context of several benefits - storm water retention, improving air quality, retention of GHGs, reducing air temperature, recreational values and aesthetic values (NYC, 2007, p. 128, 129).

Vision: In the introduction, it is stated that the city would act to increase park cover, shorten the distance every resident has to walk to reach an open green area, and create new green streets and plazas (NYC, 2007, p. 12). The standard for park territory and distance were set at 1.5 acres per 1,000 people, and a 10 minute walking distance from every household (NYC, 2007, p. 30). A goal of planting 1 million new trees by 2030 was also set (NYC, 2007, p. 38).

Actions: several actions are taken to fulfill this vision:

- Eight locations of underdeveloped open areas were located, and were designated to be redeveloped as parks, with a total territory of 500 acres (NYC, 2007, p. 33).

- Two initiatives are supposed to enhance the amount of street plants: a tree planting initiative, in which 23,000 trees would be planted per annum, as well as the green streets program, that would initiate 40 new projects per annum until 2017 (NYC, 2007, p. 38).
- Designated open areas were selected for reforestation efforts for the coming 10 years (NYC, 2007, p. 128).

Implementation: Specific goals were mentioned for every action, with changing time frames. A series of maps presents the location of the suggested efforts and the proposed implementation by 2030 (NYC, 2007, p. 39). The reforestation efforts were budgeted with 118 million USD for a period of 10 years (NYC, 2007, p. 128). Park development was budgeted with 386.4 million USD for a period of 10 years, and the park and recreation department was named as the implementing agency. Street greening efforts were budgeted with 261.9 million USD for a period of 10 years and the park and recreation department was named as the implementing agency. Implementation milestones were set for 2009 and 2015 (NYC, 2007, p. 147).

(D) Avoiding or reducing impervious surfaces

Information: The need to increase the ratio of pervious surfaces in the city in order to allow storm water infiltration and reduce surface runoff is discussed (NYC, 2009, p. 60).

Action: The document states the intention to convert asphalt fields into multi-purpose turf fields, to allow sport activity and to make them environmentally friendly, yet no climate change purpose was stated (NYC, 2007, p. 36). A planning guideline would require off-street parking lots larger than 6,000 square feet to undergo perimeter landscaping and to incorporate infiltration measures such as tree planting (NYC, 2007, p. 60).

Implementation: Changing the zoning code to implement this obligation in the short run is done by the department of city planning (NYC, 2007, p. 149), the Best Management Practice agency is responsible for developing specific licensing guidelines after appropriate research (NYC, 2007, p. 60).

(E) Re-naturalizing river systems and flood plains

Vision: In the introductory chapter, it is stated that the city would act to reduce pollution in waterways and preserve natural areas by the rivers (NYC, 2007, p. 12).

Actions: As a natural means of water filtration, 20 cubic meters of ribbed mussel beds would be introduced as a pilot, and the results would be used to see if this method is worth applying on a larger scale (NYC, 2007, p. 59).

Implementation: The pilot was set to be completed by 2009, and was conducted by the Department of Environmental Protection. Long term goals were set to “continue to foster natural ecology of city waterways” without discussing specifics. No budget was allocated for that action (NYC, 2007, p. 149).

(F) Maintaining and managing urban green areas for flood retention and water storage

Information: The document discusses the ability of a smart design of green and open areas to capture storm water and reduce surface runoff (NYC, 2007, p. 57). The details of the specific tree pit design are detailed and sketched (NYC, 2007, p. 59). Furthermore, it is explained that NYC is one of only five major cities in the United States that does not have a filtration plant, and relies on the natural processes of water filtration in watersheds around the city. 114,000 acres of which belong to the city, while 100,000 acres belong to private owners and are used as private forests or farm land. Protecting these areas is crucial to ensure ground water recharge and the quality of drinking water (NYC, 2007, p. 66).

Vision: The 2007 plan refers to the open space plan, and explains the water storage capacity of the planned new green and open spaces that would be developed within the next 25 years. The size of these spaces and the amount of water they should be able to retain are also set. Furthermore, introducing natural water storage capacities is a part of the overall vision of the expansion of the blue belt program (NYC, 2007, p. 57).

Actions: As a part of the green street program, a smart design that would hold storm water would be implemented. One acre of street could in theory hold 55,000 gallons of storm water (NYC, 2007, p. 57). In addition, expanding the blue belt, currently implemented in Staten Island, to other boroughs is suggested. A belt of water basins were developed around the borough to allow natural capture of rain water. It is suggested that similar blue belts would be in four other areas, where suitable water bodies were located (NYC, 2007, p. 58). An additional solution would be the creation of vegetated ditches on street sides. These ditches would be dry, vegetated areas in regular days but would be designed in a way that would allow water infiltration and would direct runoff towards waterbodies during storm events (NYC, 2007, p. 60). The details of the blue belts and other green infrastructure measures that are intended to capture storm water are discussed in the waterfront plan (NYC, 2011, p. 67). A watershed protection program was initiated in order to identify sensitive areas within the watersheds, working with land owners in order to ensure sustainable practices, implement site-specific solutions, and to repair some of the waste water systems installed in some of the areas within the watershed to prevent contamination (NYC, 2007, p. 66). Further details on specific actions taken are discussed in the watershed plan (NYC, 2011, p. 68).

Implementation: In the plan, four locations were designated for the implementation of a blue belt. At the moment the blue belt consists of 10,000 acres, with the intention of expanding it by 4,000 by 2032 (NYC, 2007, p. 57). The vegetated ditches would be implemented by the Best Management Practices agency (NYC, 2007, p. 58). The watershed protection program is conducted by the Department of Environmental Protection, and has a budget of 462 million USD for a period of 10 years (NYC, 2007, p. 66).

(G) Protecting and restoring marine/coastal ecosystems

Information: when discussing the damages of hurricane Sandy, some EbA measures that buffered the storm damages were discussed, among them sand-nourished beaches that absorbed some of the waves during storm surges and reduced harm to adjacent neighborhoods, sand dunes which protected the areas behind them from flood water, and wetlands which absorbed some of the excess water (NYC, 2013, p. 43). The features a wetland has to possess in order to effectively retain flood water, namely elevated edges that would retain the storm water and allow them to filtrate, are also discussed (NYC, 2013, p. 44). A list of possible interventions that would protect the coastal environment and improve its ability to defend the city against storm surges and floods is presented, including elevated edges, sand dunes, waterfront parks, multi-purpose levees, floating islands, living shorelines, natural and constructed wetlands, polders, breakwaters, revetments and coastal morphology restoration efforts (NYC, 2013, p. 48).

Vision: in the introductory chapter, the document calls to "embrace the coastline", which includes promoting actions that "cherish natural resources" (NYC, 2013, p. 7). These efforts were already in progress and a sector-specific document was published for that purpose in 2011 (NYC, 2013, p. 40).

Actions: As for wetland conservation, the plan suggests forming a task force to conduct a study that would assist in locating existing wetlands and identify where there are gaps in state and federal protection laws (NYC, 2007, p. 61). Site specific actions to protect wetlands and other natural waterfront areas are detailed in the waterfront plan (NYC, 2011, p. 77-82). A vulnerability assessment was conducted to find out which of the interventions mentioned under information are suitable for which coastal areas (NYC, 2013, p. 50). The relevant interventions that would be applied are presented on a map (NYC, 2013, p. 51-52). Out of these suggested interventions, 37 are defined as phase 1 interventions, which are prioritized (NYC, 2013, p. 59-60).

Implementation: The actions suggested in the 2013 document are presented in a table in the implementation chapter. In this table, the leading agency is mentioned, milestones for completion by 2014 and 2020 are presented, estimated costs are calculated and a funding source for some of the interventions is mentioned. For 18 out of 37 coastal protection interventions, the source of funding is marked as "not available" or as "to be decided" (NYC, 2013, 417-419).

Co-benefits:

In the 2007 document, a logo system was designed to indicate fields in which every measure would yield benefits. Park development was marked as an action that is relevant for recreation as well as relevant for climate change (NYC, 2007, p. 33). The tree planting and street greening efforts were marked as relevant for recreation, water quality, air quality, saving energy and climate change (NYC, 2007, p. 38). The blue belt was marked as relevant for water quality, recreation, energy saving, air quality and climate change (NYC, 2007, p. 57). Green roofs were discussed both in the context of

retaining water and cooling the air, and were marked as having benefits related to reduction in energy consumption, air quality and climate change (NYC, 2007, p. 60). A table showing all the multiple benefits of every action suggested is presented in the document (NYC, 2007, p. 142-145).

5.13 Paris, France

The Paris climate change protection plan was published in 2007 and consists of 76 pages. It refers to the time frame between 2004 and 2020. This plan handles both aspects of climate change mitigation and adaptation. Thus, a significant part of the plan deals with GHG emission reduction. Chapters 1-5 of the strategy deal with mitigation in five different sectors: Buildings and public areas; Developing and distributing energy; Transport; Consumption; Economic Activities. Chapter 6 (p. 59-64) discusses adaptation measures, and the later chapters discuss different aspects of implementation (p. 64-74) (Paris, 2007, p. 1).

Measures:

(B) Promoting green walls and roofs

Information: Rooftop gardens are mentioned as measures that help tackle the UHI effect both by reducing air temperature through evapotranspiration and by providing natural cooling for buildings (Paris, 2007, p. 62).

Vision: The action plan sets a goal of achieving 20,000 m^2 of green roofs by 2009 (Paris, 2007, p. 62).

Actions: 174 locations in which green walls should be implemented were located. A similar scheme for green roofs would be promoted as well. Out of the spotted locations, 55 green walls are already implemented (Paris, 2007, p. 62).

(C) Maintaining or enhancing urban green

Information: Enhancing urban green is discussed in the context of UHI and its abilities to reduce air temperature through evapotranspiration (Paris, 2007, p. 62).

Vision: The document sets to add 100,000 trees and 32 hectares of park land by 2008 (Paris, 2007, p. 62).

Actions: Three locations for the development of new parks were located. In addition, 90 community garden projects are planned for the coming years (Paris, 2007, p. 62).

Implementation: The land of the parks and community gardens would be designated in the near city master plan (Paris, 2007, p. 62).

Co-benefits:

Alongside reducing air temperature, the carbon sequestration abilities of plants were discussed, yet it is mentioned that the amount of plants that would be needed to sequestrate enough carbon would be too large to achieve (Paris, 2007, p. 62).

5.14 Philadelphia, Pennsylvania, United States

The action plan for Philadelphia was published in November 2015 and consists of 61 pages, plus 18 pages of appendices. It is divided into three main parts: Why Climate Change Matters to Philadelphia (p. 10-19); Reducing the Risks (p. 20-57); and Looking Forward (p. 58-61). The practical chapter, "Reducing the Risks" is then divided into two sub-chapters: physical infrastructure and service delivery; and policy, planning and finance. Under these sub-chapters, each section is dealing with the responsibilities and actions taken by a certain agency or authority (Philadelphia, 2015, p. 1, 3).

Two additional documents were reviewed. The city's master plan for 2025, published in 2016, contains a chapter called "Renew" which deals with the urban environment. Since the strategy discusses the incorporation of "green storm-water infrastructure" (Philadelphia, 2015, p. 38-40, 45) and refers to a sector specific plan of the water department, which also includes a separate implementation document (Philadelphia, 2015, p. 41), measures mentioned in this document are analyzed as well.

Measures:

(B)(D)(E)(F)(I) Promoting green walls and roofs / Avoiding and reducing impervious surfaces / Re-naturalizing river systems and flood plains / Ensuring sustainable watering of green spaces

Information: Under the authorities of the water department, who is in charge of the river system in the city, the strategy regards green infrastructure as a set of control measures which could minimize flooding impacts. "Green storm water infrastructure allows for smaller-scale, decentralized source control projects, providing for an effective and highly adaptive approach to storm water management" (Philadelphia, 2015, p. 41). In the water department's plan, green storm-water infrastructure is defined as a range of soil-water-plant systems that intercept storm water, infiltrate a portion into the ground and evaporate a portion of it into the air. Measures that are mentioned as a part of this approach are permeable sidewalks and parking lots, restoration of physical habitats in stream channels, rain gardens, and roof leaders that run into lawns (Philadelphia, 2011, p. 13). Furthermore, storm-water wetlands, rain gardens, storm-water planters, tree trenches and green roofs are suggested as applicable measures. For each measure, an informative box is created in which the exact mechanism of operation is detailed (Philadelphia, 2011, p. 24).

Vision: The term "green infrastructure measures" is repeatedly mentioned as a concept that the water department should explore and promote (Philadelphia, 2015, p. 39-40, 45), it refers to a sector-

specific action plan which discusses particular measures to be implemented (Philadelphia, 2015, p. 41). The water department's plan sets a goal to convert 1/3 of the impervious cover of the city into greened areas suitable for storm-water retention, using the set of measures discussed in the informative section. Furthermore, a breakdown of the kind of properties suitable for greening is included, as well as a guidance on how solutions can be implemented into each one. The areas found suitable for greening are streets, schools, public facilities, parking, open spaces, industry-business-commerce-institutions, alleys-driveways-walkways, and homes. 45% of these are publicly owned properties (Philadelphia, 2011, p. 21-32). Furthermore, the plan suggests preserving open spaces in flood hazard areas, for example Valley Park, which can be used as a flood plain and helps protecting neighboring communities from flooding, and suggests that such areas should be taken into account in the 2035 master plan (Philadelphia, 2015, p. 51).

Actions: Promoting green storm-water infrastructure is regarded as one practice in which different measures, as discussed in the informative sections, are to be implemented. These include green roofs (B), pervious paving and de-paving of parking lots (D), adapting urban green areas to store rainwater in the form of tree trenches, bump-outs to allow runoff infiltration around pavement vegetation borders, rain gardens, storm-water wetlands and basins (F) and measures intended to store rainwater for later use, such as cisterns and rain barrels (I). (Philadelphia, 2011-2, p. 2-4). Furthermore, efforts to restore 10.1 miles of stream corridors within the city are discussed. A map of potential restoration projects is presented, yet the nature of the restoration efforts is not discussed (Philadelphia, 2011, p. 34-35). Ecological restoration projects in the city's water bodies are also mentioned in the master plan, giving an example of an undergoing restoration project in Tacony-Frankfold creek (Philadelphia, 2016, p. 148-149).

Implementation: Green City, Clean Waters is funded by a sum of 2.4 billion USD over the course of 25 years, out of which 1.67 billion USD will count for green storm-water infrastructure (Philadelphia, 2011, p. 20). An additional implementation and adaptive management document was published, covering the first 5 years of implementation. It sets the framework for implementation by setting goals for "greened" areas from the baseline of 2011 in five year intervals, until 2036 (Philadelphia, 2011-2, p. 1-4). It then details sites where action is already under construction, identifies sites for future projects, and sets the framework for a monitoring program, including a date set for a first evaluation report in 2016 (Philadelphia, 2011-2, p. 1-6). The stream corridor restoration is funded with 125 million USD, but no other implementation clauses are discussed (Philadelphia, 2011, p. 34).

(C) Maintaining / enhancing urban green

Information: Greening efforts were conducted via a separate plan, called Green2015, published in 2010. In this plan, the different benefits of urban green areas were mentioned. The emphasized benefits were social, recreational and providing protection against floods. Reducing heat stress was

mentioned as a secondary benefit (Philadelphia, 2010, p. 22). Increasing green cover and tree canopy is also mentioned in the master plan as one possible measure in order to reduce air temperature (Philadelphia, 2016, p. 147).

Vision: The 2010 document sets a goal of 500 acres of greened public land by 2015, that would be spread through the city so that as many citizens as possible would live not more than half a mile from a green area (Philadelphia, 2010, p. 3). Furthermore, the master plan suggest to increase tree canopy cover from 11% to 30% by 2035, according to the recommendations for urban areas of American Forests and University of Vermont (Philadelphia, 2016, p. 156).

Action: To achieve the goal, 4 types of open space were identified: underused areas managed by the park and recreation authority; underused public land; underused private land; and schoolyards. Public land will undergo greening measures through public funding, partnerships will be established to make green improvements in schoolyards, while legislative and taxation tools will be used to encourage the transformation of unused privately-owned land parcels to accessible parks (Philadelphia, 2010, p. 76). Introducing a guidance manual for a properly planned green space is suggested. It includes other elements discussed in other sections such as rainwater collection for irrigation, replacing asphalt with permeable surfaces and using shading trees to contribute to cooling efforts (Philadelphia, 2010, p. 98).

Implementation: In addition to the target and time frame discussed earlier and detailed in a specific action plan from 2010, in which potential areas for greening have been identified (Philadelphia, 2010, p. 80-89), it is also mentioned that the city has designated a budget of 110 million USD to the greening efforts of public lands (Philadelphia, p. 84), while additional funds are expected to be available from private sources, discussed in the implementation section of the 2010 action plan (Philadelphia, 2010, p. 96). It is roughly calculated that the greening of one acre would cost 250,000 USD (Philadelphia, 2010, p. 96). The park and recreation authority will be the leading implementing agency, on its own land and land managed by it, and with relevant agencies in case of other state properties. Furthermore, some supporting policies were offered in order to promote transformation of publicly owned land parcel into green areas: defining that a minimum of 10% of a project larger than 10,000 ft^2 should be an open and accessible green space, setting a mandatory waterfront setback of 30 m, stipulating that for every tree removed two must be planted elsewhere, and enhancing landscape standards for parking lots (Philadelphia, 2010, p. 90). In addition, the development of an in-lieu fees mechanism is suggested, in cases where development projects are not suitable for greening efforts (Philadelphia, 2010, p. 91). As for tree canopy cover, 11% cover was mentioned as the baseline data while 30% is the goal to be achieved by 2035. It is also suggested that tree density in areas owned or managed by the city would increase to 200 per acre, and that partnerships would be established to create tree planting educational programs (Philadelphia, 2016, p. 152).

(H) Promoting the use of vegetation adapted to climate change

Actions: Under the responsibilities of the park and recreation authority, it is mentioned that a pilot project for forest restoration is being explored, in which the agency is working with citizen scientists to identify growing practices suitable for Philadelphia's changing climate (Philadelphia, 2015, p. 34). It is later mentioned that based on this pilot project, it will be ensured that newly planted vegetation can handle the increased temperatures and increasing rainfall (Philadelphia, 2015, p. 35).

Implementation: This action is listed as a responsibility of the Philadelphia Park and Recreation Department. No additional clauses were mentioned (Philadelphia, 2015, p. 33-35).

Co-benefits:

When explaining the way measures are described, five factors to evaluate measures are mentioned, among them co-benefits gained by adaptation activities (Philadelphia, 2015, p. 21). In the water department's plan, which deals with a bundle of measures, mutual benefits from these measures are discussed as a whole. In several places in the document, benefits of applying green storm-water infrastructure measures are listed, including reducing effects of excessive heat, enhancing recreation, restoring ecosystems, improving air quality, saving energy and offsetting climate change (Philadelphia, 2011, p. 15, 19, 34).

Remarks:

The set of solutions suggested by the city of Philadelphia is vast, and evidence for a thoroughly planned implementation process could be identified through allocating funding and naming responsible agencies, setting clear goals and deadlines and initiating specific action plans. Nevertheless, the large number of different planning documents makes it challenging to follow and have a clear view on the larger picture. Some of the measures discussed in this chapter were only located in different action plans or the master plan, although not mentioned in the climate adaptation strategy. In some cases, for example with the greening efforts, this could result from the fact that these measures were discussed in the context of different benefits, of which reducing heat stress was only secondary. Additionally, it seems that some measures are better thought through than others. For example, while greening measures are discussed in two different action plans, including implementation clauses, others, such as adapting vegetation, are mentioned in a rather general manner.

5.15 Rio de Janeiro, Brazil

Rio de Janeiro published a resilience plan in 2016, which consists of 98 pages (Rio de Janeiro, 2016, p. 15). It was developed with the cooperation of the 100 resilient cities initiative, and is based on two additional documents in Portuguese and includes all relevant actions detailed in them. The first is the Rio de Janeiro Strategic Plan 2017-2020, and the second is Rio Visáo 500, a 50-year vision published

in 2015 (Rio de Janeiro, 2016, p. 7). It is divided into eight chapters in total - five introductory chapters that review the city's vulnerabilities and what has been done so far, and three practical chapters: Resilience Challenges (p. 32-35); Resilience Vision (p. 36-37); Goals and Initiatives (p. 38-93), which discusses six resilience initiatives (Rio de Janeiro, 2016, p. 15).

Measures:

(C) Maintaining or enhancing urban green

Information: It is mentioned that green plazas with trees and water bodies would contribute to evapotranspiration and would reduce air temperature (Rio de Janeiro, 2016, p. 56).

Vision: The document aims to plant 50,000 new trees and to make sure most of the population would live within 15 minutes walking distance from a green square (Rio de Janeiro, 2016, p. 56). Furthermore, the aspiration to protect existing valuable green areas and their ecological functions is framed as an aspiration III.4.b in Vision Rio 500 (Rio de Janeiro, 2016, p. 61).

Actions: Two related actions are mentioned:

- Intervention 3B: the city would aspire to create 78 such squares that would consist of a total area of 20,000 ft^2. They would include plants, trees, composting centers and water bodies (Rio de Janeiro, 2016, p. 56).
- Intervention 3E: restoration of the Atlantic Forest biome and creating green corridors where it is fragmented, and setting legislative measures to protect the 4,800 hectares that are not under any legal protection at this time (Rio de Janeiro, 2016, p. 61).

Implementation: Specific tree number and total territory covered are stated. Practical interventions to ensure the implementation of the suggested action are included in the strategic plan 2017-2020 as initiatives 2.06, 4.02, 4.03 and 4.10, priority areas were designated as AP3 and AP5. This project has a budget of 60 million BRL of public funds and 11.6 million BRL from external funds for the period until 2020. C40 alliance, recycling associations, urban farmers and the private sector are named as potential partners for implementation (Rio de Janeiro, 2016, p. 56). For the biome restoration a budget of 127.1 BRL is given, and the percentage of protected areas compared to the 2016 baseline were mentioned as indicators for evaluating the implementation (Rio de Janeiro, 2016, p. 61).

(E) Re-naturalizing river systems and flood plains

Information: The importance of rehabilitating the Guandu River is discussed from the perspective of water scarcity. Flood retention was mentioned as a co-benefit (Rio de Janeiro, 2016, p. 64).

Action: The idea of rehabilitating the city's water bodies is mentioned as initiative 3.06 in the 2017-2020 vision. It calls to create a water body strategy that would deal with the city's water bodies and water sources (Rio de Janeiro, 2016, p. 64).

(I) Ensuring sustainable watering of green spaces

Vision: Planning the installation of rainwater capture infrastructure was mentioned as one desired element to be integrated in the future water body strategy (Rio de Janeiro, 2016, p. 64).

Actions: As a part of initiative 3B, it is mentioned that the newly built plazas would include rainwater harvesting systems that would utilize grey water for irrigation (Rio de Janeiro, 2016, p. 56).

Co-benefits:

One of the goals of the document is to identify co-benefits that would add quality to existing projects and tackle multiple challenges with the same initiative (Rio de Janeiro, 2016, p. 30). For the biome restoration, benefits and co-benefits discussed are the protection of water sources, reduction of UHIs, greater resilience of green areas, increased biodiversity, decreased risk of fires, and raised awareness for the environment (Rio de Janeiro, 2016, p. 61). Co-benefits mentioned in the context of water body rehabilitation are flood retention, increased water availability and benefits for human health (Rio de Janeiro, 2016, p. 64).

5.16 Singapore, Singapore

The city-state published a national climate change strategy in 2008. The document consists of 50 pages and contains both mitigation and adaptation measures. It is divided into six sections: Background (p. 1-6); Vulnerabilities and Adaptation Efforts (p. 7-14); Mitigation Efforts (p. 15-32); Competency Building (p. 33-39); International Participation (p. 40-41); and Going Forward (p. 42) (Singapore, 2008, p. 1, 7, 15, 33, 40, 42). Additionally, some climate change related actions were discussed in the Sustainable Singapore Blueprint, released in 2016. Both documents were analyzed.

Measures:

(B) Promoting green walls and roofs

Information: When discussing the UHI effect, rooftop gardens and vertical building gardens are mentioned as possible measures that could, if applied, assist in reducing air temperature (Singapore, 2008, p. 10).

Vision: A target of 200 hectares of green roofs was set for 2030, compared to 78 hectares in 2016 (Singapore, 2016, p. 27).

Actions: Installation of green rooftops and vertical building gardens is encouraged through new planning guidelines and an incentive program (Singapore, 2008, p. 10-11). Furthermore, these measures are also a part of the green building rating system, Green Mark (Singapore, 2016, p. 16).

Implementation: The urban redevelopment authority and the national park board are named as the responsible agencies for the application of the guideline and incentive schemes (Singapore, 2008, p.

10-11). The housing development board is named as the leading agency with regard to applying green roofs on multi-story parking lots (Singapore, 2008, p. 11).

(C) Maintaining or enhancing urban green

Information: When discussing the UHI effect, increasing greenery in the city and developing new city parks are mentioned as possible measures that could reduce air temperature (Singapore, 2008, p. 10).

Vision: The amount of green space set in the sustainability plan is 0.8 hectare per 1,000 inhabitants, an amount that was reached in the time frame between 2008 and 2016. An additional goal is to increase the connectivity of green spaces and to achieve a 400 km long green network by 2030 (Singapore, 2016, p. 27).

- **Actions:** The city has launched two different programs intended to enhance urban greenery, detailed in Singapore, 2008, p. 11:
- "Streetscape Greenery Master Plan", which is focused on implementing streetscape greenery along roads within the city-state.
- "Community in Bloom" program that supports community gardening groups.

Implementation: Both programs are launched by Nparks, the national park authority. It mentions that by 2008, these programs are already operational. The Streetscape Greenery Master Plan has led to the planting of 62,600 new trees in 2006, and in the framework of Community in Bloom, 200 gardening groups are active (Singapore, 2008, p. 11). By 2016, close to 1,000 community gardens were established through the Community in Bloom program (Singapore, 2016, p. 20).

(F) Maintaining and managing urban green areas for flood retention and water storage

Vision: The city has launched a program called ABC Waters (Active, Beautiful, Clean) which aims to merge water catchment facilities and recreational green spaces. Since 2011, the city has increased its water catchment areas but also set a goal to incorporate these facilities in the community life (Singapore, 2016, p. 8).

Actions: In the framework of the program, canals were integrated into the city, and were incorporated into parks. Thus, an artificial stream system was created within the city. The plants used provide natural water filtration (Singapore, 2016, p. 8).

Implementation: The program is already implemented, and the water bodies are maintained by Nparks (Singapore, 2016, p. 8).

(G) Protecting and restoring marine/coastal ecosystems

Information: The plan discusses the importance of mangroves and coral reefs in preventing coastal erosion and protecting the city-state from storm surges (Singapore, 2008, p. 13).

Actions: The plan suggests establishing a coral nursery that will proactively enhance marine habitats by maximizing the survival of naturally occurring corals. Furthermore, it suggests the establishment of a long term monitoring scheme that would follow mangrove diversity and survival rates, as well as assist in developing preemptive management strategies (Singapore, 2008, p. 13).

Implementation: NParks was named as the leading agency responsible for implementing these measures (Singapore, 2008, p. 13).

Co-benefits:

When discussing the marine environments, several different benefits of protecting coral reefs were discussed, including reducing damages from storm surges and carbon sequestering (Singapore, 2008, p. 13). In the last chapter, the consideration of urban forests as a carbon sink was discussed, in addition to their contribution to reducing air temperature (Singapore, 2008, p. 42). The recreational benefits of water retention bodies as well as parks and community gardens are also discussed (Singapore, 2016, p. 8, 20).

Remarks:

Even though not discussed in detail, the two documents give the impression that a lot is being done. The 2016 document, for example, reviews measures which are already implemented, including recent measures like the water retention parks, as well as older measures, such as the river cleansing program conducted in the 1970s (Singapore, 2008, p. 8). In some cases, for example when discussing greening measures, different programs were initiated. Not enough information was given with respect to implementation within the available documents, but in the later document it was evident that actions have been done and measures have been implemented. Thus, in this case, the score reflects the quality of the relevant planning documents, even though the reader gets the impression that much more is being done in reality.

5.17 Tokyo, Japan

The climate change adaptation and mitigation policy in Tokyo is based on two documents: a climate change strategy published in 2007 which is focused on mitigation actions intended to achieve a reduction in GHG emissions, consisting of 25 pages (Tokyo, 2007, p. i), and a metropolitan environmental master plan published in 2008, consisting of 36 pages. The latter is based on the city's 10 year master plan, published two years before (Tokyo, 2008, p. 2-4).

Measures:

(A) Ensuring Ventilation from cooler areas outside the city through waterway and green areas

Vision: The document has set a target to improve the urban heat environment and mentions three pillars in doing so, among them, forming wind paths (Tokyo, 2008, p. 28).

Actions: The Tokyo Metropolitan Government has established a guideline intended to "consider layout and height of buildings to keep path for winds". These paths would connect to large green areas that would be designated as cooling spots (Tokyo, 2008, p. 29).

(C) Maintaining or enhancing urban green

Vision: The city has set a goal to create an additional 1,000 hectares of green areas and to reach a number of 1 million roadside trees by 2016, as well as create a network of connected green spaces through the city (Tokyo, 2008, p. 25).

Actions: A set of different actions are discussed in order to achieve this goal: lawn plantation in public school yards; the creation of riverfront parks; developing a permission system that would enforce land owners and developers to create and preserve green areas; and integrating new green areas into planning procedures (Tokyo, 2008, p. 24-25). Furthermore, the selection of plant species that create more shade is discussed in order to tackle the effects of the UHI effect (Tokyo, 2008, p. 29).

Implementation: The Tokyo Municipal Government is taking the leading role in implementing these actions. As the baseline data, numbers from 2003 are given. In 2003, 24% of the Tokyo ward area was covered in green areas, whereas between 1996 and 2001 the city was losing 160 hectares of green areas per year. The goal, as mentioned earlier, is to increase the green cover by 1,000 hectares by 2016. Costs of the measures were not estimated, but two optional funding sources have been mentioned: initiating a Green Tokyo fundraising campaign and using taxation to fund low-cost solutions (Tokyo, 2008, p. 24-25).

(D) Avoiding or reducing impervious surfaces

Actions: The plan suggests promoting the use of water-retaining pavement where artificial pavement is needed, but without discussing the action in detail or suggesting implementation clauses (Tokyo, 2008, p. 29). It also suggests that architecture of underground developments should not obstruct permeability of water (Tokyo, 2008, p. 27).

(E) Re-naturalizing river systems and flood plains

Vision: The document states that maintaining and improving the ecology of rivers is a step that should be considered (Tokyo, 2008. P. 27).

Action: One particular improvement is discussed in the document, and it deals with waterfront improvements that will allow natural water purification (Tokyo, 2008, p. 27).

Co-benefits:

When discussing greening actions, they are discussed in the context of UHI effect (Tokyo, 2008, p. 29), water infiltration (Tokyo, 2008, p. 27), protecting biodiversity (Tokyo, 2008, p. 30-31), and improving quality of life (Tokyo, 2008, p. 25). Permeable surfaces are discussed both in the context of UHI effect and of ground water recharge (Tokyo, 2008, p. 27-29).

5.18 Toronto, Canada

Toronto climate change action is based on several planning documents: an action plan published in 2007, discussing actions to be implemented which consists of 18 pages (Toronto, 2007, p. 1), and a strategic document discussing the implementation of the suggested actions, published in 2008 and consisting of 46 pages (Toronto, 208, p. 2). The 2007 document contains only actions (Toronto, 2007, p. 2), while the 2008 document is divided into nine chapters. Chapters 3-5 (p. 5-16) comprise the informative part of the document, chapters 6 and 7 (p. 17-39) detail the desired actions and chapter 8 (p. 40-42) present a summary for the implementing procedures. Chapter 6 is focused on short term adaptation actions, while the 7th sets the theoretical foundations for a longer, more comprehensive strategy (Toronto, 2008, p. 2). The 3rd document is an update to the original report, published in 2011 (Toronto, 2011, p. 1). The flood protection plan from 2003 which was referred to in these documents was also analyzed.

Measures:

(B) Promoting green walls and roofs

Information: Green roof installations are used as an example for actions that "reduce greenhouse gas emissions and protect against climate change", without discussing which particular effects it hinders (Toronto, 2008, p. 4). Later it is explained that green roofs capture and retain storm water as well as contributing to cooling down buildings (Toronto, 2008, p. 16).

Vision: The need to require and regulate green roofs in the city and update the building code and green development standard accordingly is mentioned (Toronto, 2007, p. 5). It later sets a goal for green or eco roofs in 10% of all industrial, commercial and institutional roof spaces by 2020 (Toronto, 2008, p 6).

Action: to be achieved through incentive programs to encourage the incorporation of green roofs into new projects and renovation actions. It also calls for integrating existing projects in that field into the new incentive programs (Toronto, 2007, p. 6; 2008, p. 16). Furthermore, a city-wide analysis will be conducted to find the optimal locations to install green roofs (Toronto, 2008, p. 18). Starting in 2010, new developments with a gross area of more than 2,000 m^2 are obliged to implement a green roof (Toronto, 2011, p. 1).

Implementation: A target of 10% by 2020 was mentioned, and City Planning was named as the leading agency. A supporting policy intended to create suitable incentives is already in place (Toronto, 2008, p. 16). According to this policy, starting 2006, applicants can receive a grant of 50 CAD per square meter of built green roof. The first 2 years of implementation were budgeted by Toronto Water with a sum of 200,000 CAD per year (Toronto, 2003, p. 36).

(C) Maintaining or enhancing urban green

Information: Several benefits of urban forests are discussed in the context of climate change adaptation both in the adaptation strategy and in the wet weather master plan. These are shading, cooling and reducing runoff. Additional benefits discussed are absorption of air pollutants, habitat for birds, the ability to sequester carbon and providing an attractive environment (Toronto, 2003, p. 37; Toronto, 2008, p. 9). Furthermore, it explains that these functions would reduce the UHI effect (Toronto, 2008, p. 16).

Vision: The city has committed to doubling its tree canopy from 17% in 2007 to 34% in 2050 (Toronto, 2008, p. 16; 2007, p. 12). Additionally, increasing park cover from 30% to 50% of the city's land is set as a goal (Toronto, 2008, p. 19).

Actions: In the informative chapters, some actions that are already in progress are detailed. Among them, tree planting and green space protection are mentioned, including increasing the life span of trees in commercial areas from six to 35 years, increasing street tree planting and increasing enforcement of planting requirements for private land (Toronto, 2008, p. 14, 19). Furthermore, suitable land was acquired by the city wherever possible. The land acquisition efforts were aimed at purchasing large tracts of land in locations where forests would assist the efforts in preserving the natural hydrological processes in watersheds, as well as creating continuous green corridors (Toronto, 2003, p. 37). A series of tree planting projects were described in the 2011 adaptation actions report (Toronto, 2011, p. 4-6).

Furthermore, a green development standard was introduced, in which a commitment of new development action to enhance neighborhood green space was discussed (Toronto, 2008, p. 16). Between 2003 and 2008, 4 million CAD were allocated for acquisition of land designated to undergo forestation efforts (Toronto, 2003, p. 37). This is also mentioned in the city's master plan, where a planning requirement is set, according to which of 5% of each new development project should be dedicated to park land, and in case it is deemed impossible, a cash-in-lieu compensation mechanism will be applied (Toronto, 2015, p. 86). Additionally, a program intended to engage citizens in small-scale urban greening projects was introduced, in which information kits were prepared and distributed (Toronto, 2008, p. 17).

Implementation: In 2008, the city allocated 24 million CAD to increasing tree cover. In addition, the operational budget of the City's Forest Unit was increased by 40 Million CAD a year (Toronto, 2008,

p. 3). Different agencies were named in the context of each measure in respect to greening efforts. City Planning was named as the leading agency responsible for applying the green building standards (Toronto, 2008, p. 18), Forest and Recreation alongside the Toronto Environment Office were named as the leading agencies responsible for the community engagement program (Toronto, 2008, p. 17), and the Forestry and Recreation department was named as the leading agency responsible for expanding parkland (Toronto, 2008, p. 19). Between 2003 and 2008, 636,000 CAD were allocated to support community greening projects (Toronto, 2003, p. 62).

(D) Avoiding or reducing impervious surfaces

Information: It is stated that green parking lots are expected to reduce heat and runoff, without going into details (Toronto, 2008, p. 16). In the wet weather flow master plan, concrete information regarding the effects of different kinds of land cover on infiltration and evapotranspiration rates is detailed (Toronto, 2003, p. 35). The effects of permeable parking lots according to the city's guideline per ha are calculated and presented in the wet weather master plan (Toronto, 2003, p. 53).

Actions: It is stated that a draft guideline for green parking lots is being prepared and that some pilot projects are in progress, without going into detail (Toronto, 2008, p. 16). Furthermore, the need to engage the business sector to install permeable pavements in parking lots is mentioned (Toronto, 2008, p. 29). A feasibility study on the implementation of porous paving city-wide started in 2005, yet no results or recommendations were found (Toronto, 2003, p. 56).

Implementation: The city's planning department was named as the responsible agency (Toronto, 2008, p. 16). The guideline was approved by the city council and has been in effect since February 2010 (Toronto, 2003, p. 51-52).

(E) Re-naturalizing river systems and flood plains

Vision: In the wet weather flow master plan, an EbA-related objective was discussed. Objective 8 calls to "protect, enhance and restore natural features and functions" of the city's waterbodies (Toronto, 2003, p. 18).

Actions: One action designated to achieve this objective is stream restoration. It names some actions that should be taken, and that are needed to be planned on a watershed/sub-watershed level. These actions include: restoration of degraded sections of the streams using natural channel design techniques; revegetation of stream banks; removal/modification of a number of fish barriers; reforestation and creation of wetland; restoration of existing wetlands or marshes (Toronto, 2003, p. 32).

Implementation: Several site-specific restoration projects are detailed in the plan. It also sets a goal of restoring 100 km of streams, which is a quarter of the city's stream system, in the time frame between 2003 and 2027. It is mentioned that the estimated cost would be around 100 million CAD

over 25 years, and that a sum of 12.5 Million CAD was allocated for restoration projects to be conducted between 2004 and 2008 (Toronto, 2003, p. 33). In the first 5 years of implementation, five new wetlands would be constructed, in an investment of 5.8 million CAD (Toronto, 2003, p. 44).

Co-benefits:

As mentioned in the informative section of each measure, different positive effects of greening efforts as well as green roofs are discussed. Furthermore, in the strategy, a chart reviewing different positive effects on both mitigation and adaptation is presented (Toronto, 2008, p. 38).

Remarks:

The 2007 and 2008 documents are used as preliminary action plans, intended to understand the vast impacts climate change has on the city, implement some short term measures and test through pilot projects possible long term solutions, as well as engage the public in these actions and create additional funding sources, with a goal of creating a comprehensive strategy at a later stage (Toronto, 2008, p. 21-22). The only large scale plan is that initiated in 2003 and is meant to handle extreme weather events, in particular floods, and a large part of the actions described later are a part, or based on, what was offered in that document. In general, from all the potential risks of climate change, EbA measures are utilized mainly to prevent floods, while heat events are generally treated with other adaptive measures, for example emergency services preparedness. Nevertheless, side effects, including cooling, of some of the EbA measures discussed in other contexts, are also presented.

Table 8: Summary of the results

Glossary:
in. = information
vi. = vision
ac. = actions
im. = implementation

	A				B				C				D				E				F				G				H				I			
	in.	vi.	ac.	im.	in.	vi.	ac.	im.	in.	vi.	ac.	im.	in.	vi.	ac.	im.	in.	vi.	ac.	im.	in.	vi.	ac.	im.	in.	vi.	ac.	im.	in.	vi.	ac.	im.	in.	vi.	ac.	im.
Bangkok									1	2	1	2																								
Chicago					2	3	2	2	2	2	3	2	3		1	1					2	3	2	2					1	1					2	
Delhi										3	3	3	2		2	3	3	3	2	1			1	3												
HCMC		1			2	1			3	3	2	3		1			2	1	1		2		1								2					
HK					2	2																														
Karachi					2	1			3	1			3				2	1																		
Kolkata					3	1	2	3	3	2	1	3	3	3	1	3																				
Lagos										1	2	1													3	1	2	1	2		1	1				
London		3	1		3	3	3	2	3	3	3	3		3	2	2		3	3	3	2	1	3	3												
LA									2	3	3	1		1				3	1		1	1	1	2												
Mumbai									1	1	3	2	3		2	2																				
NYC					3		3	2	3	3	3	3	3		3	3		1	1		3	3	3	3	3	3	3	3								
Paris					3	3	3		3	3	2	1																								
Phil.					3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3							1	1	3	3	3	3
Singapore					3	3	3	2	3	3	3	2		3	3	3									3		2	1								
Rio									3	3	3	3					1		1			2	2													
Tokyo		1	2							3	3	2			1			1	1																	
Toronto					1	3	2	3	3	3	3	3	3		1	2		1	3	3																

6. Results

6.1 Distribution of Measures

6.1.2 Distribution by Measures

Table 9: Distribution of measures accross components 1-3 of the action plans, including average scoring. The Average scoring was calculated as follows:
Average 1: Score / Number of mentions for the specific component
Average 2: Score / Number of times a measure was mentioned
Average 3: Score / Number of case studies

Measure	A	B	C	D	E	F	G	H	I	Total
No. Cities (in %)	3 (16.6%)	11 (61.1%)	17 (94.4%)	13 (76.4%)	10 (55.5%)	8 (44.4%)	3 (16.6%)	4 (22.2%)	2 (11.1%)	71
Information (Av. 1/ Av. 2/ Av. 3)	0 (0/0/0)	11 (2.54/ 2.54/ 1.5)	14 (2.5/ 2.05/ 1.94)	8 (2.87/ 1.76/ 1.27)	5 (2.2/ 1.1/ 0.61)	7 (2.28/ 2/ 0.88)	3 (3/ 3/ 0.5)	2 (1.5/ 0.75/ 0.16)	1 (3/ 1.5/ 0.16)	51 (2.49/ 1.78/ 0.78)
Percentage	0%	100%	82.3%	61.5%	50%	87.5%	100%	50%	50%	71.8%
Vision (Av. 1/ Av. 2/ Av. 3)	3 (1.66/ 1.66/ 0.27)	10 (2.3 / 2.09/ 1.27)	17 (2.47/ 2.47/ 2.33)	6 (2.33/ 1.07/ 0.77)	9 (1.88/ 1.7/ 0.94)	6 (2.16/ 1.62/ 0.72)	2 (2/ 1.33/ 0.22)	1 (1/ 0.25/ 0.05)	1 (3/ 1.5/ 0.16)	55 (2.21/ 1.71/ 0.75)
Percentage	100%	90.9%	100%	46.1%	90%	75%	66.7%	25%	50%	77.4%
Actions (Av. 1/ Av. 2/ Av. 3)	2 (1.5/ 1/ 0.16)	8 (2.62 / 1.91/ 1.16)	16 (2.56/ 2.41/ 2.27)	10 (1.9 / 1.46/ 1.05)	9 (1.77 / 1.6/ 0.88)	8 (2/ 2/ 0.88)	3 (2.33 / 2.33/ 0.38)	3 (1.33/ 1/ 0.22)	2 (2.5/ 2.5/ 0.27)	61 (2.16/ 1.86/ 0.81)
Percentage	66.7%	72.7%	94.1%	76.9%	90%	100%	100%	75%	100%	85.9%

In total, 71 EbA measures were found in the action plans of the 18 case study cities. Table 9 shows a detailed summary of how many times measures appeared, in which part of the plan, and how detailed the information regarding the measures was. The first insight one can observe with regard to the distribution of EbA measures in action plans, is that measure C is the most common measure to be planned, as seen in figure 1. Greening measures were found in the action plans of 17 out of the 18 cities examined, which represents 94.4% of action plans, while Hong Kong was the only city not to include this measure in its action plan. Measures A, G and I were the less common measures which were found three, three and two times respectively, which represent 16.6% and 11.1% of the action plans respectively. Furthermore, 14 of the cities explained the function of greening measures, and out of them 10 cities have discussed the effects of urban green areas on air temperature, and the role that they play in the context of adaptation. 17 cities have included greening measures in their vision, and 16 have taken greening action - every city besides Hong Kong and Karachi.

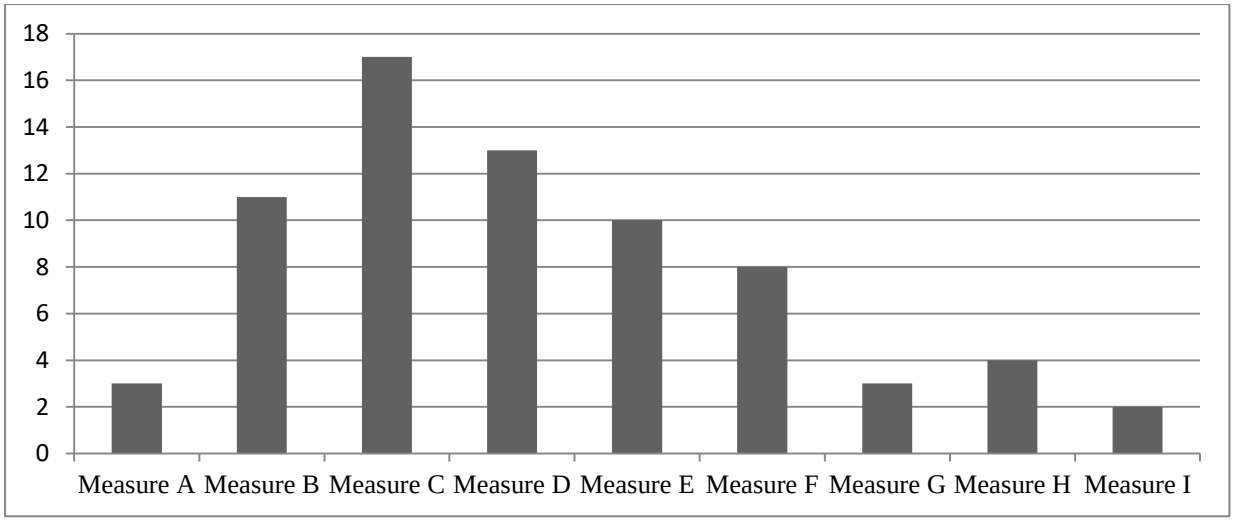


Figure 1: Number of times a measure was mentioned, according to the classification of measures in chapter 3.2

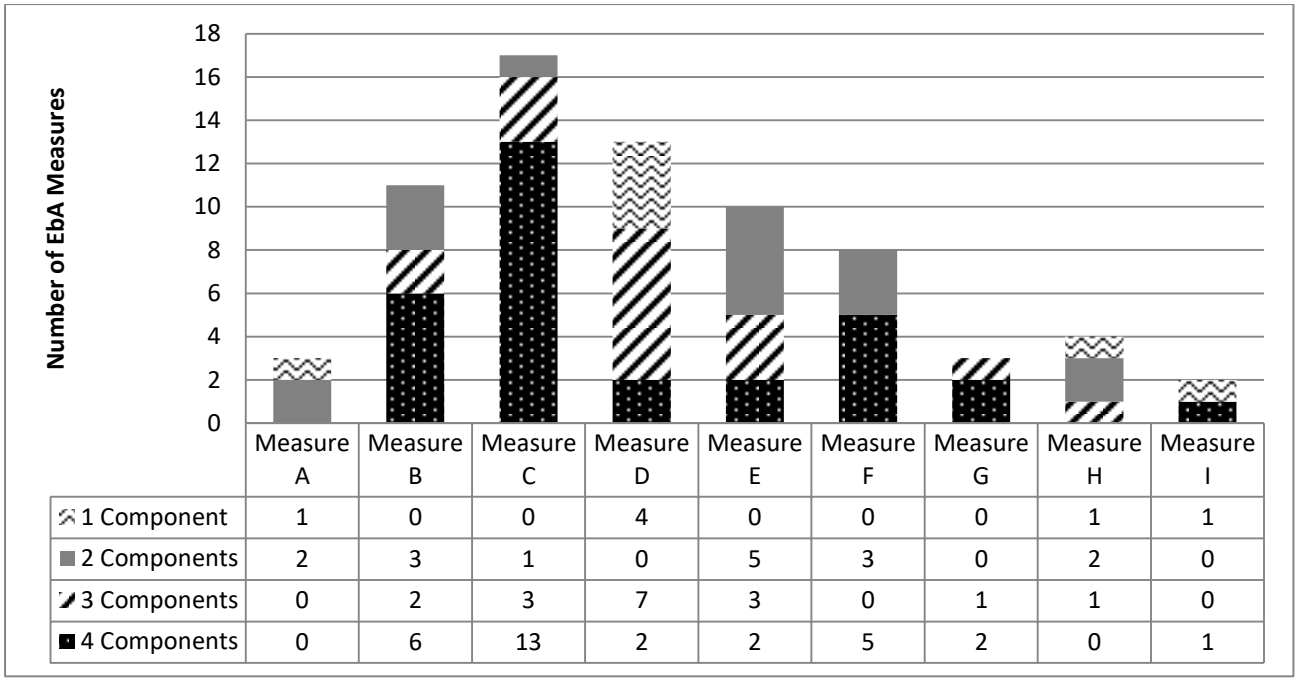
In total, out of 71 measures, 51 included information regarding their operation, which represents 69% of the measures. Out of these, in 31 cases the information was comprehensive and was rated with the maximal score, which represents 43.6%. The average score for information regarding EbA measures, whenever such information was found, was 2.51, and 1.73 when calculating all measures found. Information regarding measure A did not appear in any of the action plans, while all plans which included measures B and G provided information regarding them. In the case of measure G, not just that information was provided in all cases in which the measure was discussed, but in all cases it was comprehensive enough to be rated with the maximal score, although when calculating the grand total average, it only reaches the score of 0.5 due to the low number of times it was mentioned. Measure D had an average score of 2.87, meaning that in the cases information was discussed, thorough information was provided only in 61.5% of the cases, which would make the total average score 1.76. The second highest average score in that case is for measure C, with a total average of 2.11. When taking a look at the grand total average, measure C scored the highest with 2. The per-measure average was slightly above the general average for this section, yet due to the large number of times this measure was discussed, it ended up with a significantly higher score in the grand total.

In 55 cases, a vision or targets were discussed, which represents 77.4% of the measures found. Out of these, in 32 of the cases the vision component included quantifiable objectives and links to other policy or planning processes, and was given the maximal score, therefore in 45% of cases. Measures A and C included a vision every time a measure was mentioned (3 and 17 times, respectively). Measures B and E included a vision in 90% of the cases (10 of 11 and 9 of 10 respectively). A vision regarding measures H and I were only discussed once, which represents 50% of the times the measure was discussed in total in the case of measure I and 25% in the case of measure H. Measure D included as a vision in less than half of the times the measure itself was discussed – six out of 13 cases, which represents 46.1%. Measure I achieved the highest score in the only case a vision was mentioned, yet

in the grand total it has achieved a low score of 0.16. With respect to vision, measure C was discussed in the most comprehensive way, with an average score of 2.47 per mention and 2.33 in total. An interesting difference is observed between measures B and E, where even though mentioned a similar amount of times, the difference in score is significant. Measure B achieved the score of 2.3 per mention and 1.27 in total, while measure E reached 1.88 per mention and 0.94 in total.

Out of the 71 measures, 61 included practical actions to be taken, which consists of 85.9% of the measures. This figure shows that from all thematic categories, actions were most commonly present. In 27 of the cases, a sufficient amount of information was included to be rated with the highest score, which consists of 44% of the times actions were discussed and 38% of the times measures were mentioned. Measures F, G and I included specific actions in all the cases they were mentioned (8, 3 and 2 respectively), while measure C had an action attached to it in the largest number of cases, in 16 of the cities, which are 94.1% of the 17 times the measure was found and 88.8% of the case studies. Measure A was translated into action in the lowest rate, 66.7% (2 of 3 cases) and measure D had the largest number of mentions that did not translate into action (3 out of 13). Measure C has the highest average rate, both per mention and in overall. In 11 cases, the actions related to measure C were sufficiently detailed to be graded with the highest score, and the average score was 2.56 in the 16 cases an action was present, 2.41 when considering the times the measure was mentioned and 2.27 in the overall calculation. Measure B did score slightly higher on the average rate per action with 2.62, with 5 of 8 mentions receiving the maximum score (62.5%), yet in the overall calculation the average score was lower due to the lower number of times it was mentioned.

Out of the 71 EbA measures discussed in the action plans, 31 were discussed in all 4 thematic components of the action plans (43.6%), 17 include 3 out of 4 components (23.9%), 16 include 2 components (22.5%) and 7 of the measures include only 1 of the thematic components (9.8%). On average, whenever an EbA measure appeared in an action plan, it appeared in 2.98 of the thematic components. While measures B, C, F and G were mentioned in all thematic components more than half of the times they were mentioned, measures A and H did not include all 4 components in any of the cases. Measure C appeared on average in 3.7 of the components every time it was mentioned, measure G in 3.66 of the components and measure B in 3.27 of the components. Measure A had the lowest rate of inclusion in that sense, where it was included in only 1.66 of the components every time it was mentioned. Out of the 9 times a measure included only 1 of the components, 4 of them were when measure D was discussed.



	Measure A	Measure B	Measure C	Measure D	Measure E	Measure F	Measure G	Measure H	Measure I
1 Component	1	0	0	4	0	0	0	1	1
2 Components	2	3	1	0	5	3	0	2	0
3 Components	0	2	3	7	3	0	1	1	0
4 Components	0	6	13	2	2	5	2	0	1

Figure 2:Ratio of inclusion of the measure in the different components of the action plans, per measure overview

The measures were grouped into three categories, according to the impact to which they are adapting. Measures A, B and C are affecting air temperature. Measures D, E, F and G are intended to assist in preventing or reducing flooding. Measures F, H and I contribute to fresh water availability. Measure F is related to two impacts, thus counted twice, in both groups. It is evident that EbA measures are considered in the context of flooding (34 measures, 43%) and heat stress (31 measures, 39%) much more than in the context of water scarcity (14 measures, 18%).

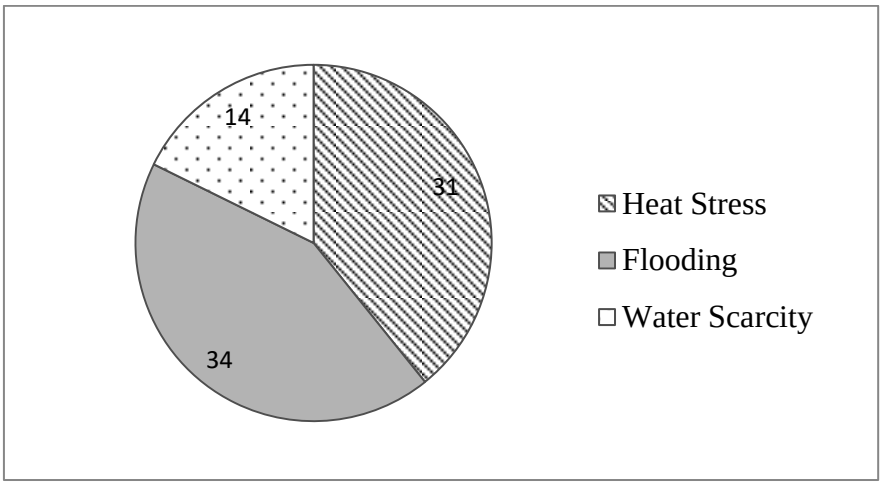


Figure 3: Distribution of EbA measures found according to the group of impacts they tackle

6.1.1 Distribution by City

Table 10: Distribution of measures by city, over components 1-3, including average scoring.
Average 1: Score / Number of mentions for the specific component
Average 2: Score / Number of times a measure was mentioned
Average 3: Score / Number of case studies

City	Bangkok	Chicago	Delhi	HCMC	Hong Kong	Karachi	Kolkata	Lagos	London	Los Angeles	Mumbai	New York City	Paris	Philadelphia	Rio de Janeiro	Singapore	Tokyo	Toronto
Measures	1	6	4	7	1	4	3	3	6	4	2	6	2	7	3	4	4	4
Inf.	1	5	3	4	1	4	3	2	3	2	2	5	2	6	2	3	0	3
Av. 1	1	2	2.66	2	2	2.5	3	2.5	2.66	1.5	2	3	3	3	2	3	0	2.33
Av. 2	1	1.66	2	1.14	2	2.5	3	1.66	1.33	0.75	2	2.5	3	2.57	1.33	2.25	0	1.75
Vis.	1	4	2	5	1	3	3	2	6	4	1	4	2	6	2	3	3	3
Av. 1	2	2.25	3	1.4	2	1	2	1	2.66	2	1	2.5	3	3	2.5	3	1.66	2.33
Av. 2	2	1.5	1.5	0.85	2	0.75	2	0.66	2.66	2	0.5	1.66	3	2.57	1.66	2.25	1.25	1.75
Act.	1	5	4	4	0	0	3	3	6	3	2	6	2	7	3	4	4	4
Av. 1	1	2	2	1.5	0	0	1.33	1.66	2.5	1.66	2.5	2.66	2.5	2.71	2	2.75	1.75	2.25
Av. 2	1	1.66	2	0.85	0	0	1.33	1.66	2.5	1.25	2.5	2.66	2.5	2.71	2	2.75	1.75	2.25
Av. 1	1.33	2.07	2.44	1.61	2	1.85	2.11	1.71	2.6	1.77	2	2.73	2.83	2.89	2.14	2.9	1.71	2.3
Av. 2	1.33	1.61	1.83	1	1.33	1.08	2.11	1.33	2.16	1.33	1.66	2.27	2.83	2.61	1.66	2.41	1	1.91
Av. 3	0.14	1.07	0.81	0.77	0.14	0.48	0.7	0.44	1.44	0.59	0.37	1.51	0.62	2.03	0.55	1.07	0.44	0.85

In total, in the action plans of the 18 cities examined, 71 EbA measures were found. On average, 3.94 measures were mentioned in the action plans of each city. The median number of measures is 4, 6 cities incorporated 4 measures in their action plans, 5 cities had a larger number of measures, and 7 cities incorporated less than 4 measures. The highest number of measures in one action plan was 7, by Ho Chi Minh City and Philadelphia, and the least was 1, in the action plans of Bangkok and Hong Kong.

Looking merely at the number of measures discussed however, could be misleading. Two additional factors were analyzed – how many of the thematic elements were discussed when a measure appeared, and into what level of detail, rated by the scoring system explained in chapter 4.2.

First, figure 5 shows the distribution of measures according to the number of the thematic components in which a measure was discussed. Comparing the two case study cities which include the largest number of EbA measures in their action plans, shows how differentiated it could be. While in the action plan of Philadelphia, 6 of the 7 EbA measures discussed included all 4 thematic components, in the case of Ho Chi Minh City, only 1 measure included all 4 thematic components, and 3 of them included only 1 component. The average score calculated for the measures discussed in these two action plans also differs significantly; where Philadelphia scored on average 2.61 per measure mentioned and 2.03 in total, Ho Chi Minh City has an average of 1 per measure and 0.77 in total.

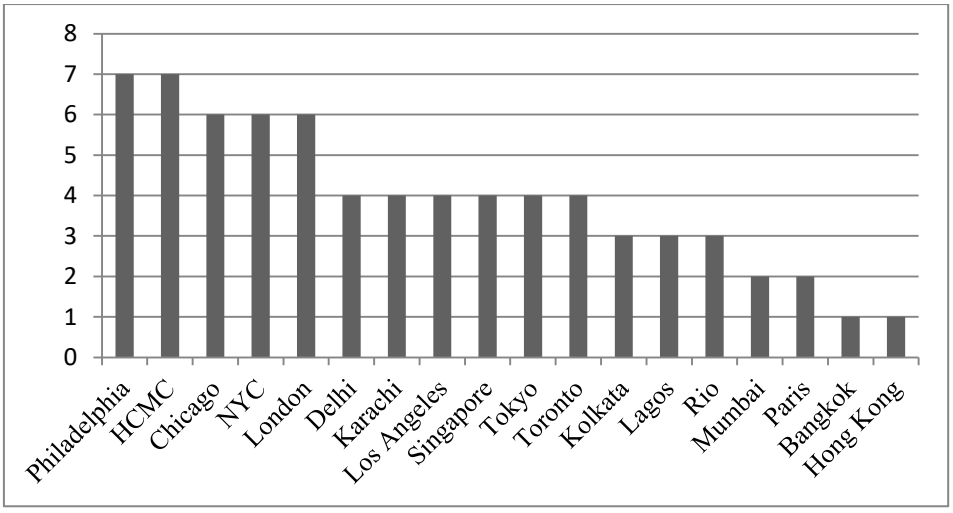
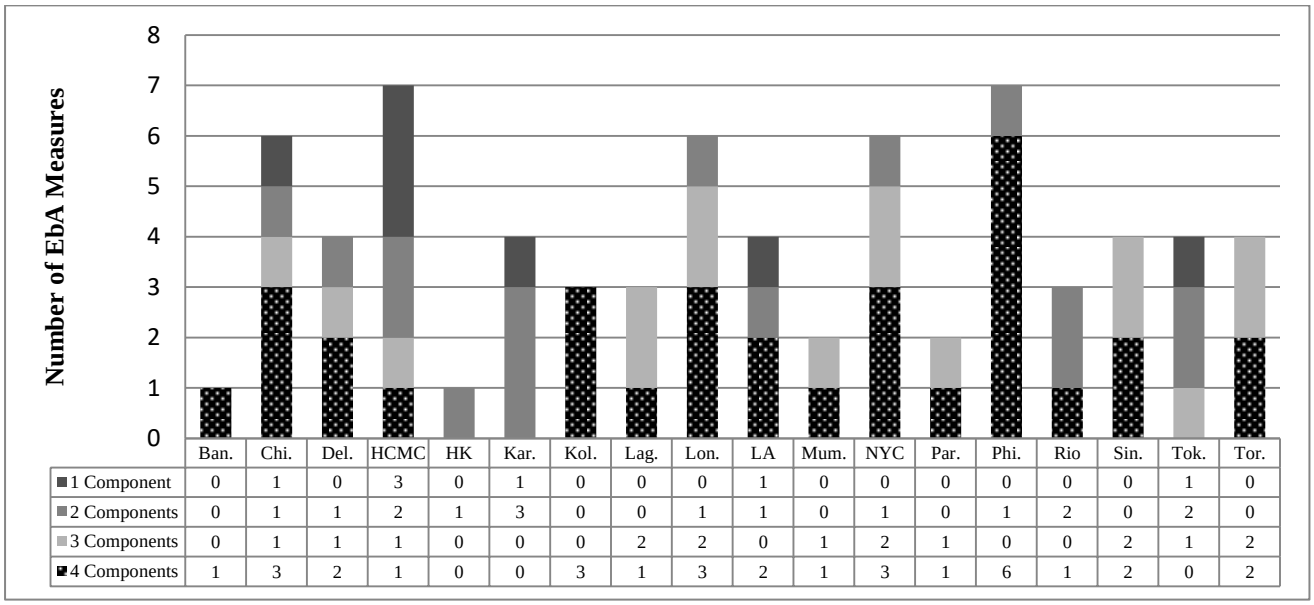


Figure 4: Number of measures recorded per city, arranged from high to low

Second to Philadelphia, the best scoring action plans are New York City and London, with 6 measures each and a total average score of 1.51 and 1.44 respectively. The lowest total average score was recorded, naturally, by the action plans of the cities where the least measures were recorded - Bangkok and Hong Kong, with 0.14. When calculating the average per measure, Ho Chi Minh City was the city with the lowest average score, and the only one with an average score of less than 1 per measure (0.95). The cities with the highest per-measure average score were Paris (2.83) and Philadelphia (2.61).



	Ban.	Chi.	Del.	HCMC	HK	Kar.	Kol.	Lag.	Lon.	LA	Mum.	NYC	Par.	Phi.	Rio	Sin.	Tok.	Tor.
1 Component	0	1	0	3	0	1	0	0	0	1	0	0	0	0	0	0	1	0
2 Components	0	1	1	2	1	3	0	0	1	1	0	1	0	1	2	0	2	0
3 Components	0	1	1	1	0	0	0	2	2	0	1	2	1	0	0	2	1	2
4 Components	1	3	2	1	0	0	3	1	3	2	1	3	1	6	1	2	0	2

Figure 5: Ratio of inclusion of the measure in the different components of the action plans, per measure overview
Abbreviated: The names of the cities in alphabetical order

Another differentiation is between the different thematic parts of the action plans and the type of information detailed regarding each measure. Generally, all 3 thematic parts discussed in this sub-chapter are present in most of the cases where a measure was found. In 71.8% of the cases information was included, in 77.4% a vision was presented and in 85.9% a specific action, or actions, were included. Information regarding the measures and their relevance was generally included and attached to all, or all but one of the measures in most of the cities, with the exception of four: The action plan of Tokyo did not include any information regarding the relevance of EbA measures and their operation mechanisms, in HCMC information was included in only 4 out of 7 cases, and in the cases of London, Delhi and Mumbai, such information was included in only half of the cases (3 of 6, 2 of 4 and 1 of 2 respectively).

In the case of what is classified as a vision, a more even distribution is seen, and all of the action plans analyzed included a vision or targets attached to their measures. Some differentiation was observed for the level of detail in which a vision was discussed and objectives were defined. Four cities: Paris, Singapore, Philadelphia and Delhi presented a clear vision and defined objectives every time those were discussed. In the cases of Karachi, Lagos and Mumbai, the vision and objectives were only general, and the average score of the vision and objectives located was 1.

Actions were attached to the vast majority of measures located, and here the quantitative division showed some cases with an outstanding difference. 13 of the 18 cities had an action attached to all measures found, and in two more, in all but one of the measures found. In the case of Hong Kong, Karachi and Ho Chi Minh City, an exception was seen. In the cases of Karachi and Hong Kong, no practical action was taken. In the case of Hong Kong that could be related to the nature of the action plan, which dealt with mitigation rather than with adaptation to begin with, and in the case of Karachi, it can be related to the fact that the plan falls into the category of preparatory action plans, as defined by Kern & Adler (2009) and discussed in chapter 2.3. Two additional action plans that could be defined as preparatory are those of Kolkata and Ho Chi Minh City. Those did include some actions to be taken, in 4 of 7 cases in the case of Ho Ci Minh City and in all 3 cases in the case of Kolkata, yet those were described in a general manner and did not provide a clear picture on where or how they should be applied. Similar to the case of Hong Kong is that of Bangkok. Although there an action was attached to the only EbA measure found, it was discussed in a rather general manner, which could be related to the fact this action plan had a declared focus on mitigation efforts.

As for the quality of the actions taken, generally in most cities the average score for actions taken was at least 2, for whenever an action was taken, with the exception of the cities mentioned in the previous paragraph, alongside Los Angeles (1.66) and Tokyo (1.75).

6.2 Implementation

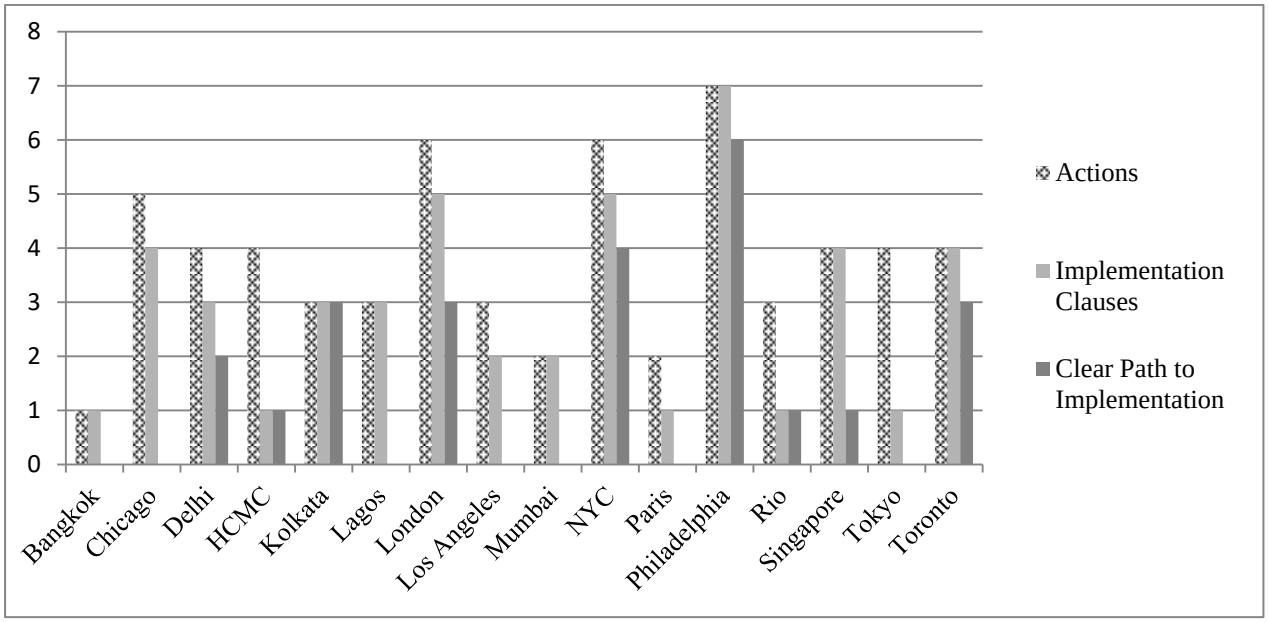


Figure 6: Number of actions mentioned which included implementation clauses, and those which presented a clear path to implementation

Out of 71 EbA measures mentioned in the analyzed action plans, 47 included implementation clauses (66.1%). When compared to the number of actions mentioned (61), it is evident that 77% of actions did entail at least some implementation clauses. In total, 16 out of the 18 cities included at least some implementation clauses for the measures discussed. Without going into the quality of these clauses, six of the cities have included implementation clauses for all the measures, and four more include implementation clauses for all but one of the measures discussed. The action plans of Hong Kong and Karachi are the only documents not to discuss any implementation clauses, but those did not include specific actions to begin with.

Table 11: Average scoring for implementation clauses, per city overview

City	Bangkok	Chicago	Delhi	HCMC	Hong Kong	Karachi	Kolkata	Lagos	London	Los Angeles	Mumbai	New York City	Paris	Philadelphia	Rio de Janeiro	Singapore	Tokyo	Toronto
Av. 1	2	1.75	2.33	3	0	0	3	1	2.6	1.5	2	2.8	1	2.71	3	2	2	2.75
Av. 2	2	1.4	1.75	0.75	0	0	3	1	2.16	1	2	2.33	0.5	2.71	1	2	0.5	2.75

24 measures across all action plans provided sufficient information that allowed a clear path towards implementation (33.8% of all measures found). These are spread between 9 of the 18 cities (50%). In the action plan of Kolkata, a clear implementation roadmap is detailed for all three EbA measures

present, while Philadelphia demonstrates a clear path for the largest number of measures, 6 out of the 7 that were discussed.

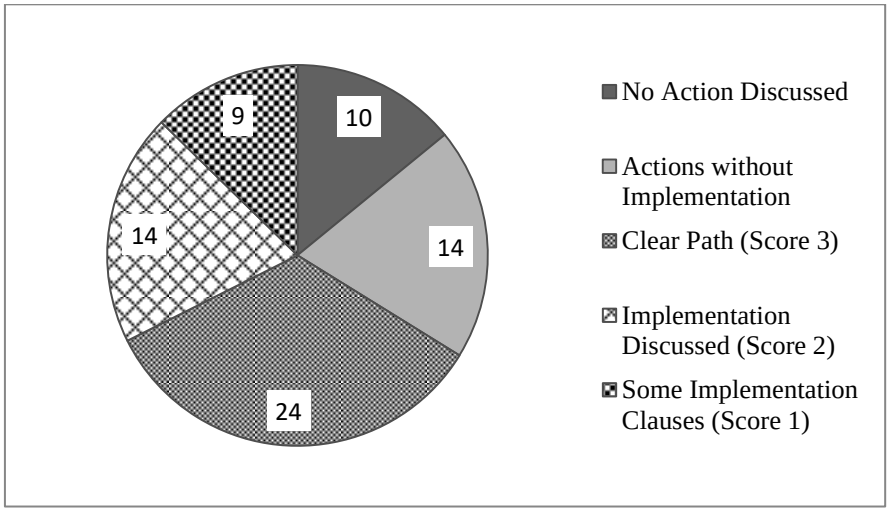


Figure 7: Scoring for implementation clauses across EbA measures found

As for the quality of the documents with respect to implementation clauses, the average score is 2.42 when considering only measures which provided information regarding implementation, and 1.78 when considering all actions discussed.

Three cities, HCMC, Mumbai and Rio de Janeiro, had an average perfect score for the measures that had implementation clauses, meaning that all implementation clauses presented were complete. Nevertheless, in the case of HCMC and Rio de Janeiro, they include implementation clauses only for a small part of the measures discussed. As we can see in the last row of the table, where the calculated average also includes actions to which implementation clauses were not discussed, the average score of these two cities drops to 0.75 and 1 respectively. Seven cities had an overall average score of 2 or more for their implementation clauses: Bangkok, London, Mumbai, New York City, Philadelphia, Singapore and Toronto.

Table 12: Preconditions for implementation. per-measure overview
Average 1: Score / Number of implementation clauses
Average 2: Score / Number of actions

Measure	A	B	C	D	E	F	G	H	I
Actions	2	8	16	10	9	8	3	3	2
Imp. Clauses	0 (0%)	7 (87.5%)	16 (100%)	9 (90%)	4 (44.4%)	5 (62%)	3 (100%)	2 (66.6%)	1 (50%)
Clear Path	0 (0%)	3 (37.5%)	8 (50%)	5 (50%)	3 (33.3%)	3 (37.5%)	1 (33.3%)	0 (0%)	1 (50%)
Av. 1	0	2.42	2.31	2.44	2.5	2.6	1.66	1	3
Av. 2	0	1.54	2.17	1.69	1	1.62	1.66	0.5	1.5

As the distribution of implementation clauses per measure shows, two measures stand out with a high rate of including implementation clauses once discussed - protecting marine/coastal ecosystems (G) and protecting/enhancing urban green (C). These included implementation clauses in all cases (3 and 16 respectively) in which an action was discussed.

When looking at the number of times a clear roadmap for implementation was presented, measures C, D and I included complete implementation clauses in the highest part of rate, 50% of the times an action was detailed. It is important to mention however, that measure I only represents 1 case, while in the case of measures C and D it represents 8 and 5 actions respectively. No implementation clauses were recorded to begin with for measure A, and none of the four times measure H was discussed included sufficient information regarding implementation.

When compared to the total percentage of measures that included sufficient information regarding implementation (39.3%) we can see that measures C, D and I had an above average rate in including sufficient implementation information, and measures A, B, E, F, G and H were below the average rate.

Although some measures have achieved a high score regarding their implementation clauses whenever those were included, only measure C had an average score higher than 2 in the final calculation, thus when looking at the measures mentioned in total, it seems that enhancing urban green is the measure which is the most likely to be successfully implemented in the case studies analyzed in this thesis.

6.3 Co-benefits

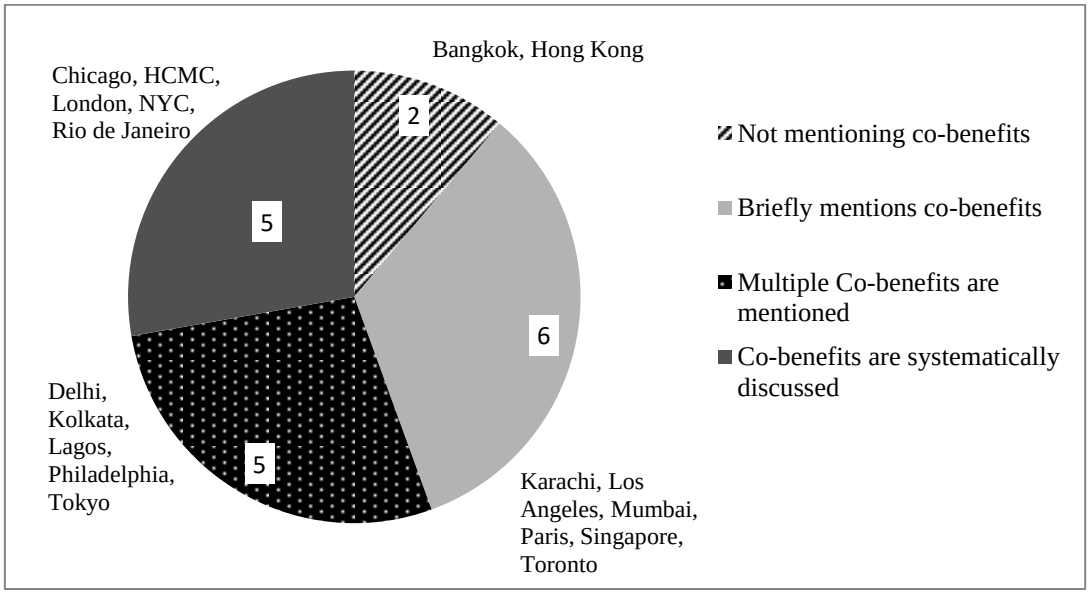


Figure 8: Scoring for the consideration of the potential of utilizing multiple benefits and pursuing win-win solutions in the climate change action plans analyzed

For this part, the issue of co-benefits as a whole is analyzed, without a division per measure. In 16 of the 18 case studies the issue of co-benefits was addressed to some extent. In 5 of the 18 case studies, there was a systematic thought on the idea of pursuing co-benefits and trying to create win-win situations. In 11 of the case studies, co-benefits were not handled systematically, yet multiple benefits of some of the measures were discussed, whether briefly or in detail. In total, the average score in that section was 1.72. Only two cities did not mention multiple benefits at all - Bangkok and Hong Kong. However, it is important to remind again, that in the action plans of these two cities little evidence for EbA measures was found to begin with.

Among the five cities dealing with co-benefits systematically in the action plans, some differences could be observed. Although all of them fall into the definition of addressing this issue systematically, some did this more thoroughly than others. In the action plan of London, an additional chapter discussed the potential multiple benefits of measures included in the plan, including a table in which all potential co-benefits were summarized. The action plans of New York City and Rio de Janeiro contained a system to indicate the potential for achieving co-benefits and applied it when measures were discussed. In the case of Chicago, a system similar to those applied in the action plans of New York City and Rio de Janeiro was applied, but in a more generalized manner. It referred to a group of measures, and gave indication for other fields it might positively affect, without going into details. In the case of Ho Chi Minh City, guiding principles for applying multifunctional solutions that would serve different purposes were discussed, and potential multiple benefits of adaptation measures were presented in the introduction. Furthermore, the importance of pursuing this direction was emphasized. However, co-benefits were not addressed in the context of specific adaptation actions in the practical parts of the action plan. The score in the case of Ho Chi Minh City was not a clear-cut decision, yet due to the importance given to the thought of multiple benefits as a guiding principle I have decided to categorize it as an action plan that has systematically addressed the issue.

The 11 case studies that have been rated 1 and 2 are split somewhat equally, with 5 cities which have discussed multiple benefits thoroughly and 6 that have mentioned them briefly. In this case, as an answer to RQ3, it is evident that even though co-benefits were only discussed systematically in 28% of the cases, they were addressed in the vast majority of action plans – 16 of 18, which represents 88.8%.

7. Categorizations and Comparison

7.1 Distribution of Measures between Developed and Developing Countries

In total, in the action plans of nine cities in developed countries 43 measures were found (60.5%), while in action plans of cities in the developing world, 28 measures were found (39.5%). On average, 4.77 measures were found in the action plan of each city in a developed country, compared to 3.11

measures in action plans of cities in developing countries. That makes 34.9% fewer EbA measures in action plans of cities in developing countries.

Also when looking at how comprehensive the planning of these measures was, and thus in how many of the components of a plan measures appeared, a difference can be observed. While in action plans of cities in developed countries, each measure was found on average in 3.2 of the components, whereas in cities in developing countries each measure appeared in 2.6 of the components. The average scoring for the different action plans also differs. Figure 9 shows the different scoring calculated for the action plans (without implementation, which is discussed separately). There it is evident that in all three different calculations, both those who take into account the number of measures or components, and also the average scoring only for the places a measure was found, a higher score was found in the case of cities in developed countries. Naturally, since fewer measures were found in action plans of cities in developing countries, and those were discussed in less of the components in average, it is natural that the difference will grow from one calculation to another. Yet it is observable already from the initial calculation.

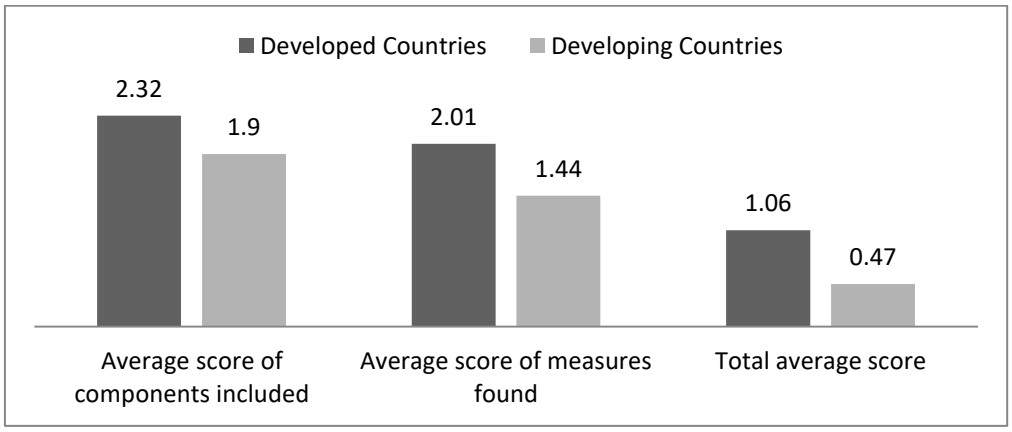


Figure 9: Differences in average scoring of the action plans (components 1-3) between cities in developed and in developing countries

Tables 13 and 14 show the distribution of each measure between cities in developed and developing countries. The purpose of this distribution is to find out whether some of the measures are more commonly applied in developed or developing countries. As we can see, none of the measures are applied in developing countries more commonly than in developed countries. Yet, two measures are applied an equal number of times: Measure F (managing urban green areas for flood retention) and measure H (promoting the use of adapted vegetation). In addition, measure C (protecting /enhancing urban green) was applied in all cities in developed countries and in all but one of the cities in developing countries, thus 12% less.

When taking a look at which measures were applied more often in cities in developed countries, one can see that measure I (ensuring sustainable watering of green spaces) was applied only in cities in the developing world (Chicago, Philadelphia). Measures A, B, D and G were applied more commonly in

the developing world, in a percentage that is larger than the average deviation (50-37%), and measure E was applied more commonly in the developed world at a rate similar but slightly higher than the average deviation (33%).

Table 13: Distribution of measures between action plans of cities in developed and in developing countries, per-measure overview

Measure	A	B	C	D	E	F	G	H	I
Developed	2	7	9	8	6	4	2	2	2
Developing	1	4	8	5	4	4	1	2	0
Difference	50%	43%	12%	37%	33%	0%	50%	0%	100%

7.2 Differences in Actions and Implementation between Developed and Developing Countries

The first difference can be observed when looking at the number of times a measure discussed included an action. In cities in developed countries, almost all EbA measures found in the action plans entailed an action. However in cities in developing countries, only 71% of the EbA measure found included practical actions to be taken. A difference, although smaller, can be observed when looking at the rates in which an action discussed included implementation clauses – 70% of the cases in developing countries and 82.9% of the cases in developed countries. A similar percentage of the implementation clauses were complete and provided a clear roadmap towards implementation.

Action plans of cities in developing countries did not only include information regarding implementation of the measures in a larger rate and number of times, but also included more information regarding the implementation process. The average score per implementation provision was 1.92 in the case of cities in developing countries, and 2.37 in the case of cities in developed countries.

Table 14: Preconditions for implementation, distribution between cities in developed and in developing countries

	Cities in developing countries	**Cities in developed countries**
Measures	28	43
Actions	20 (71%)	41 (95%)
Implementation	14 (70%)	34 (82.9%)
Clear Roadmap	7 (50%)	16 (47%)

7.3 Differentiation by the type of regime

The Economist Democracy Index classifies countries into 4 categories: full democracies, flawed democracies, hybrid regimes and authoritarian regimes (EIU, 2016). According to the 2016 edition, 5 of the 18 case study cities are located in countries which have been classified as hybrid (Pakistan, Nigeria and Thailand) or authoritarian (China and Vietnam). The rest of the relevant countries have

been classified as flawed or full democracies (EIU, 2016). Since all 5 case studies under non-democratic regimes are in the developing world, two forms of comparison were made: the results of the non-democratic case studies were compared both to the 4 democratic case study cities who are located in the developing world, and to the sum of 13 case study cities located in countries with democratic regimes.

When comparing the number of measures appearing in the action plans, among the 5 non-democratic case studies, 3.2 EbA measures appeared on average in each action plan. In the action plans of case studies in democratic and developing countries, on average 3 EbA measures appeared in each plan, and in the action plans of all 13 case study cities in democratic countries, 4.2 measures appeared on average. The difference becomes more significant when looking at how many of these measures are translated into actions and include information regarding implementation. In the 5 non-democratic case study cities, 1.6 measures on average included a description of a specific action, compared to 3 on average in the democratic-developing case studies and 4.07 among all democratic case studies. When considering implementation, on average 1 measure included implementation clauses in the action plans of non-democratic case studies, compared to 2.25 in the case of democratic-developing case studies and 3.07 in the case of all democratic case studies.

The level of detail which the documents contain also differs between regime forms. While the measures described in the action plans of the non-democratic case studies had an average score of 1.2, in the democratic case studies the average was 1.75 in the case of the developing world, and 1.93 in the general calculation. The average score for implementation clauses was 1.2 where they have appeared and 0.75 in total in the case of non-democratic case studies, 2.58 and 1.93 in democratic-developing case studies, and 2.26 and 1.77 in the case of all democratic countries.

7.4 Unique Adaptation of Coastal and Delta Cities

All 18 case study cities are crossed by a river. Yet, some of them also lie on the coast or on a river delta. Cities that lie on a coastal region or on a river delta are at a higher risk of floods (Balica et al, 2012; McGrannahan et al, 2007). 12 of the 18 cities analyzed are coastal or delta cities. Six of them are not connected to an ocean or a river delta, although two of them are located on a large lake. Here a comparison is made to see whether coastal and delta cities use EbA measures to tackle flood risk more often than those cities which are farther from the coast. Measure G will not be counted in this analysis, since it is only relevant to coastal cities.

9 of the 12 coastal and delta cities included flood-related EbA measures in their action plans (75%), with a total of 18 measures, an average of 1.5 per action plan. In comparison, 5 of the 6 non-coastal cities (83%) included these measures in their action plans, with a total of 13 measures - 2.16 per action plan. The average score for these measures and the inclusion of implementation differs greatly between the two groups, where in the group of coastal cities 5 of the 18 measures included

implementation clauses, in comparison to 12 of the 13 measures in the case of non-coastal cities. The average score of the measures in the group of coastal cities was 1.18, while in the group of non-coastal cities the average score was 1.94 per measure.

It is evident that coastal proximity does not play a role in considering EbA measures as flood protection in the case studies analyzed, yet it is important to mention that the group on non-coastal cities includes 5 cities from developed countries and no cities from non-democratic countries, which, as we have seen in chapters 6.4.2 and 6.4.3, consider less EbA measures in their action plans.

7.5 Differentiation by number of plans per city

In order to get an overview of that difference, the cities were divided into two groups. Group 1 consists of 11 of the cities which had only one relevant climate change related planning document available for analysis: Bangkok, Delhi, Ho Chi Minh City, Hong Kong, Karachi, Kolkata, Lagos, Los Angeles, Mumbai, Paris and Rio de Janeiro. Out of these, in 7 of the cases this document was the only one to be analyzed, and in 4 of them, the action plan referred to the master plan, which was also available. Group 2 consists of the other 7 cities, which had more than one relevant document which was analyzed: Chicago, London, New York City, Philadelphia, Singapore, Tokyo and Toronto. In this case, those were either sector specific plans (green network, clean air plan, etc.) or environmental plans (green city design sustainable urban plan, etc.). Within this group, two of the cities referred to a master plan, in addition to the multiple action plans found.

The first difference which could be observed is the number of measures per city. In the case of the cities with only one action plan, 34 measures were discussed, an average of 3.09 per city. In the case of the cities with multiple plans, a total of 37 measures were discussed, an average of 5.2 per city. The number of times a measure included an action and implementation clauses was also different in the two cases. While in the first group of cities 25 of the 34 measures described included an action to be taken (73.5%), in the second group of cities it was included in 36 of the 37 cases (97.2%). In the first group of cities, 17 of the 25 actions found included implementation clauses (68%), while in the second group, 30 of the 36 actions included such clauses (83.3%).

In order to see whether there was also a difference in the quality of the information given, not just in the number of times EbA measures were included, a summary of the average scores was made as well. The average scores per measure were considered, so that the number of measures would not affect this comparison. The average score per measure (excluding implementation) in cities of the first group was 1.45, while in the second group it was 1.92. In the case of implementation, the average per action was considered for the calculation, and in that case the difference between the two groups is even larger. The average score for implementation clauses was 1.4 in the first group and 2.05 in the second.

8. Conclusions and Recommendations for Further Research

RQ1 asked to what extent do EbA measures appear in the climate change action plans. The results of the analzsis with regard to this question appeared in chapter 6.1. The inclusion of EbA measures varied greatly from city to city, and from measure to measure. One pattern stands out from the results: enhancing and protecting urban green areas as means of climate change adaptation was considered in almost every planning document analyzed. This correlates with findings of other studies, mentioned in the literature review, which show that adapting to heat-related impacts are the most common when considering EbA measures (Wamsler, 2015) and that greening measures are a common practice among urban planners, regardless of the benefits of those in relation to climate change adaptation (Tzoulas et al, 2007; Geneletti & Zardo, 2016). Unlike Wamsler's (2015) findings, in this thesis it is shown that in the case of large cities, EbA measures are considered both in the case of flood risk and of heat-related impacts, although less in tackling water scarcity.

Although relevant measures that could be considered as ecosystem-based were found in the action plans, it is evident that EbA is rarely discussed as a concept. In only one of the case studies, Lagos, the term EbA was used in a direct connection with the measures found in the plan. As Wamsler et al (2014) and Wamsler (2015) suggest, the terminology of EbA is not yet clear, which makes tracing these measures, and possibly also intentionally incorporating them into planning procedures, a harder task. To improve this, further research on conceptualizing EbA in the urban context is needed. The framework set by the EEA (2012) is a starting point, although relevant mostly for European cities. Further research is needed in order to set the guidelines around the concept of EbA and better define the relevant measures for cities in a global context, create a common terminology, and differentiate it better from other similar approaches.

RQ2 asked to what extent do the plans discuss the implementation of the planned measures. The case of implementation shows a complex picture, as seen in chapter 6.2. As noted in chapter 2.3, the relevant literature (Wheeler, 2008; Satterthwaite et al, 2007, among others) suggests that implementation is one of the main barriers to planned adaptation. In the case of EbA measures in large cities, it is evident that although most of the measures discussed entail some information regarding their implementation, only a third of them (33.8%) include all the information needed to provide sufficient preconditions to a successful implementation. Furthermore, from all four thematic components defined, preconditions for implementation were included the least frequently.

RQ3 dealt with the consideration of these co-benefits of EbA measures and the prospect of pursuing win-win solutions in the action plans. The literature suggests that one of the strengths of EbA is the possibility to utilize co-benefits (Munang et al, 2013; CBD, 2009). In most action plans, as seen in chapter 6.3, multiple benefits of EbA measures were considered to some extent, but it is evident that only a small group of cities has tackled the topic in a systematic manner.

As for answering RQ4, which asked what conditions could affect the inclusion of EbA measures in the action plans, two characteristics of cities have proven to matter. First, as seen in chapters 7.1 and 7.2, a difference between cities in developed countries and cities in developing countries was observed. Although suggested to be particularly useful in the developing world (Vignola et al, 2009; Van Bauern, 2012), cities in developed nations considered more EbA measures in their climate change action plans, and also provided better conditions for those measures to be implemented. The differences could be observed using every tool used for analysis in this thesis – number of measures, number of components in which a measure was discussed, number of actions, inclusion of preconditions for implementation and an average score for the level of detail in which those are discussed. This could raise a point for future research, on developing better mechanisms for planning adaptation in general, and EbA in particular, which take into account the obstacles common for cities in the developing world.

The second criteria that have shown a difference was the type of regime in a country. Although the number of EbA measures considered did not change significantly between cities in democratic and non-democratic nations, it is evident that actions to be conducted and the preconditions provided to implement them are lacking some specific information in the case of non-democratic regimes. Furthermore, as seen in chapter 7.4, even though coastal and delta cities are at higher risk of flooding as a result of climate change, there is no evidence that those cities use EbA solutions to tackle these risks more than other cities.

One of the criteria for differentiation between the case studies was technical – the number of relevant planning documents per city. This study has shown that cities with more relevant planning documents also include more EbA measures, and discuss them in a more detail. Those cities with multiple relevant plans were all from developed countries, which correlates with the findings regarding the inclusion of EbA measures.

This thesis studied the presence of EbA measures in municipal action plans and evaluated the extent to which these were included. However, it was beyond the scope of this thesis to examine the quality and implementation of the measures themselves. For example, a systematic, well planned process for planting 200 trees has received a higher score in comparison to a plan to create a massive urban forest, which lacked information regarding funding. An interesting point for further research would be to evaluate the quality and implementation of the measures themselves, rather than just the process of planning. In the future, studies conducted on a larger scale could incorporate both approaches and give a more comprehensive picture regarding the application of EbA in large cities.

Another point is the issue of language. This thesis was limited to cities which published their action plans in English, thus limiting the number of possible case studies to 18. Additional case studies that would provide a wider base for comparison could be analyzed, for example a similar study could be

conducted by a person or a group who could analyze documents in other languages. Spanish would be crucial for this, since many large cities in Latin America have published climate change action plans which could be relevant for this study.

9. Sources

9.1 Literature List

Adger, N. Huk, S. Brown, K. Conway, D. and Hulme, M. 2003. *Adaptation to Climate Change in the Developing World.* In: Progress in Development Studies 3(3): 179-195

Ahern, J. Cilliers, S. and Niemlä, J. 2014. *The Concept of Ecosystem Services in Adaptive Urban Planning and Design: A Framework for Supporting Innovation.* In: Landscape and Urban Planning 125: 254-259

Anguelovski, I. and Carmin, J. 2011. *Something Borrowed, Everything New: Innovation and Institualization in Urban Climate Governance.* In: Current Opinion in Environmental Sustainability 3: 1-7

Baker, I. Peterson, A. Brown, G. and McAlpine, C. 2012. *Local Government Response to the Impacts of Climate Change: An Evaluation of Local Climate Action Plans.* In: Landscape and Urban Planning 107: 127-136

Balica, S.F., Wright, N.G. and van der Meulen, F. 2012. *A Flood Vulnerability Index for Coastal Cities and its Use in Assessing Climate Change Impacts*. In: Natural Hazards 64:73-105

Bolund, P. and Hunhammar, S. 1999. *Ecosystem Services in Urban Areas.* In: Ecological Economics 29: 293-301

Bulkeley, H. 2010. *Cities and the Governing of Climate Change.* In: Annual Review of Environment and Resources 35: 229-253

Campbell, A. Kapos, V. Chenery, A. Kahn, S. Rashid, M. Scharlemann, J. and Dickson, B. 2009. *The Linkage between Biodiversity and Climate Change Mitigation.* UNEP World conservation monitoring center

Convention on Biological Diversity (CBD). 2009. *Year in Review.* Montreal: CBD

Daily, G. 1997. *Nature's Services: Societal Dependence on Natural Ecosystems.* Island Press, Washington, DC

De Sherbinin, A. Schiller, A. And Pulsipher, A. 2007. *The Vulnerability of Global Cities to Climate Hazards.* In: Environment & Urbanization 19(1): 39-64

Demograpgia. 2017. *Demographia World Urban Areas. 13th Annual Edition.* Available online at: http://www.demographia.com/db-worldua.pdf. (Last Access: 26.04.2017)

Dodman, D. and Satterthwaite, D. 2008. *Institutional Capacity, Climate Change Adaptation and the Urban Poor.* In: IDS bulletin 39: 67-74

Dodman, D. McGranahan, G. and Dalal-Clayton, B. 2013. *Integrating the Environment in Urban Planning and Management: Key Principles and Approaches for Cities in the 21st Century.* Nairobi: UNEP

Economist Intelligence Unit (EIU). 2016. *Democracy Index 2016.* Available online at: https://psv4.userapi.com/c810539/u16929061/docs/91138ee069cc/The_Economist_Intelligence_Unit_Democracy_index_2016_2017_FreeMags_cc_1.pdf (Last Access: 28.03.2017)

European Environmental Agency (EEA). 2012. *Urban Adaptation to Climate Change in Europe: Challenges and Opportunities for Cities Together with Supportive National and European Policies.* EEA Report No 2/2012. Luxembourg/Copenhagen: EEA

Folberth, G. Butler, T. Collins, W. and Rumbold, S. 2015. *Megacities and Climate Change – A Brief Overview.* In: Environmental Pollution 203: 235-242

Füssel, H. 2007. *Adaptation Planning for Climate Change: Concepts, Assessment Approaches, and Key Lessons.* In: Sustainability Science 2: 265-275

Gill, S. Handley, J. Ennos, A. and Pauleit, S. 2007. *Adapting Cities for Climate Change: The Role of the Green Infrastructure.* In: Built Environment 33(1): 115-133

Geneletti, D. and Zardo, L. 2016. *Ecosystem-based Adaptation in Cities: An Analysis of European Urban Climate Adaptation Plans*. In: Land Use Policy 50: 38-47

Glasow, R. Jickells, T. Baklanov, A. Carmichael, G. Church, T. Gallardo, L. Hughes, C. Kanakidou, M. Liss, P. Mee, L. Raine, R. Ramachadran, P. Ramesh, R. Sundseth, K. Tsunogai, U. Uematsu, M. and Zhu, T. 2013. *Megacities and Large Urban Agglomerations in the Coastal Zone: Interactions between Atmosphere, Land, and Marine Ecosystems.* In: Ambio 42: 13-28

Gomez-Baggethun E. and Barton, D. 2013. *Classifying and Valuing Ecosystem Services for Urban Planning.* In: Ecological Economics 86: 235-245

Grimm, N. Faeth, S. Golubiewski, N. Redman, C. Wu, J. Bai, X. And Briggs, J. 2008. *Global Change and the Ecology of Cities.* In: Science 319: 756-760

Heidrich, O. Dawson, R. Reckien, D and Walsh, C. 2013. *Assessment of the Climate Preparedness of 30 Urban Areas in the UK.* In: Climatic Change 120: 771-784

Hsieh, H. and Shannon, S. 2005. *Three Approaches to Qualitative Content Analysis.* In: Qualitative Health Research 15(9): 1277-1288

Hunt, A. and Watkiss, P. 2011. *Climate Change Impacts and Adaptation in Cities: A Review of the Literature.* In: Climatic Change 104(1): 13-49

Huq, S. Kovats, S. Reid, H. and Satterthwaite, D. 2007. *Editorial: Reducing Risks to Cities from Disasters and Climate Change.* In: Environment and Urbanization 19(1): 3-15

ICLEI. 2010. *Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation.* Available online at: http://www.fcm.ca/Documents/tools/PCP/changing_climate_changing_communities_ guide_for_municipal_climate_adaptation_EN.pdf (last access: 16.03.2017)

Intergovernmental Panel on Cliamte Change (IPCC). 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC.* Cambridge: Cambridge University Press

Intergovernmental Panel on Cliamte Change (IPCC). 2014. *Climate Change 2014: Synthesis Report.* Geneva: IPCC

Jones, H. Hole, D. and Zavaleta, E. 2012. *Harnessing Nature to Help People Adapt to Climate Change.* In: Nature Climate Change 2: 504-509

Kern, K. and Alber, G. 2009. *Chapter 8: Governing Climate Change in Cities: Modes of Urban Climate Change Governance in Multi-Level Systems.* In: The International Conference on Competitive Cities and Climate Change, Milan: 171-196

Kleerekoper, L. van Esch, M. And Salcedo, T. 2012. *How to Make a City Climate-Proof, Addressing the Urban Heat Island Effect.* In: Resources, Conservation and Recycling 64: 30-38

Kovats, S. and Akhtar, R. 2008. *Climate, Climate Change and Human Health in Asian Cities.* In: Environment & Urbanization 20(1): 165-175

Laukkonen, J. Blanco, P. Lenhart, J. Keiner, M. Cavric, B. And Kinuthia-Njenja, C. 2009. *Combining Climate Change Adaptation and Mitigation Measures at the Local Level.* In: Habitat International 33: 287-292

McDonald, R. Green, P. Balk, D. Fekete, B. Revenga, C. Todd, M. and Montgomery, M. 2011. *Urban Growth, Climate Change, and Freshwater Availability.* In: Proceedings of the National Academy of Sciences 108(15): 6312-6317

McGranahan, G. Balk, D. and Anderson, B. 2007. *The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones.* In: Environment and Urbanization 19(1): 17-37

Mercer, J. Kelman, I. Alfthan, B. and Kurvits, T. 2012. *Ecosystem-Based Adaptation to Climate Change in Caribbean Small Island Developing States: Integrating Local and External Knowledge.* In: Sustainability 4(8): 1908-1932

Molina, M. and Molina, L. 2004. *Megacities and Atmospheric Pollution.* In: Journal of the Air & Waste Management Association 54(6): 644-680

Moser, S. and Eckstrom, J. 2010. *A Framework to Diagnose Barriers to Climate Change Adaptation.* In: Proceedings of the National Academy of Sciences 107(51): 22026-22031

Moser, C. and Satterthwaite, D. 2010. *Towards Pro-Poor Adaptation to Climate Change in the Urban Centers of Low- and Middle-Income Countries.* In: Mearns, R. and Norton, A. (Editors). 2010. Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World. Washington, DC: World Bank

Müller, N. Kuttler, W. And Barlang, A. 2014. *Counteracting Urban Climate Change: Adaptation Measures and Their Effect on Thermal Comfort.* In: Theoretical and Applied Climatology 115(1): 243-257

Munang, R. Thiaw, I. Alverson, K. Mumba, M. Liu, J. and Rivington, M. 2013. *Climate Change and Ecosystem-based Adaptation: A New Pragmatic Approach to Buffering Climate Change Impacts*. In: Current Opinion in Environmental Sustainability 5: 1-5

Niemelä, J. Saarela, S. Söderman, T. Kopperoinen, L. Yli-Pelkonen, V. Väre, S. and Kotze, J. 2010. *Using the Ecosystem Services Approach for Better Planning and Conservation of Urban Green Spaces: a Finland Case Study.* In: Biodiversity Conservation 19: 3225–3243

Neumann, S. Anzaldua, G. Gerdes, H. Frelih-Larsen, A. Davis, M. Berry, P. Burch, S. And Sanders. M. 2011. *Assessment of the Potential of Ecosystem-based Approaches to Climate Change Adaptation and Mitigation in Europe. Final Report to the European Commission, DG Environment.* Oxford: Ecologic Institute and Environmental Change Institute, Oxford University Center for the Environment

Pérez, A. Herrera Fernández, B. and Gatti, R. (editors) 2010. *Building Resilience to Climate Change: Ecosystem-based Adaptation and Lessons from the Field*. Gland, Switzerland: IUCN

Reckien, D. Flacke, J. Dawson, R. Heidrich, O. Olayabal, O. Folez, A. Hamann, J. Orru, H. Salva, M. De Gregorio Hurtado, S. Geneletti, D. and Pietrapertosa, F. 2014. *Climate Change Response in Europe: What's the Reality? Analysis of Adaptation and Mitigation Plans from 200 Urban Areas in 11 Countries.* In: Climatic Change 122: 331-340

Roberts, D. Boon, R. Diederichs, N. Douwels, E. Govender, N. McInnes, A. McLean, C. O'Donoghue, S. and Spires, M. 2012. *Exploring Ecosystem-based Adaptation in Durban, South Africa: "Learning-by-Doing" at the Local Government Coal Face.* In: Environment and Urbanization 24(1): 167-195

Stone, B. 2012. *The City and the Coming Climate: Climate Change in the Places We Live*. New York: Cambridge University Press

Stone, B. Vargo, J. and Habeeb, D. 2012. *Managing Climate Change in Cities: Will Climate Action Plans Work?* In: Landscape and Urban Planning 107: 263-271

Satterthwaite, D. Huq, S. Pelling, M. Reid, H. and Lankao, P. 2007. *Adapting to Climate Change in Urban Areas: The Possibilities and Constrains in Low- and Middle-Income Nations.* Bellagio: IIED

Tang, Z. Brody, S. Quinn, C. Chang, L. and Wei, T. 2010. *Moving from Agenda to Action: Evaluating Local Climate Change Adaptation Plans.* In: Journal of Environmental Planning and Management 53(1): 41-62

Tzoulas, K. Korpela, K. Venn, S. Yli-Pelkonen, V. Kazmiercyak, A. Niemlä, J. And James, P. 2007. *Promoting Ecosystem and Human Health in Urban Areas using Green Infrastructure: A Literature Review.* In: Landscape and Urban Planning 81: 167-178

Uitto, J. 1998. *The Geography of Disaster Vulnerability in Megacities: A Theoretical Framework.* In: Applied Geography 18(1): 7-16

United Nations Department of Economic and Social Affairs. 2007. *World Urbanization Prospects: The 2007 Revision.* New York: United Nations Press

United Nations Department of Economic and Social Affairs. 2014. *World Urbanization Prospects: The 2014 Revision*. New York: United Nations Press

Van Beuern, E. 2012. *Chapter 1: Introduction.* In: Van Beuern, E. Van Bohemen, H. Itard, L. and Visscher, H. (editors). 2012. Sustainable Urban Environments: An Ecosystem Approach. Dordrecht: Springer

Vignola R. Locatelli B. Martinez C. and Imbach P. 2009. *Ecosystem-based Adaptation to Climate Change: What Role for Policy-Makers, Society and Scientists?* In: Mitigation and Adaptation of Strategies for Global Change 14: 691-696

Wamsler, C. Luederitz, C. and Brink, E. 2014. *Local Levers for Change: Mainstreaming Ecosystem-based Adaptation into Municipal Planning to Foster Sustainability Transitions.* In: Global Environmental Change 29: 189-201

Wamsler, C. 2015. *Mainstreaming Ecosystem-based Adaptation: Transforming toward Sustainability in Urban Governance and Planning.* In: Ecology and Society 20(2): 30

Wheeler, S. 2008. *State and Municipal Climate Change Plans: The First Generation.* In: Journal of the American Planning Association 74(4): 481-496

World Bank. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based Adaptation to Climate Change.* Washington, DC: World Bank

Zeppel, H. 2013. *The ICLEI Cities for Climate Protection Programme: Local Government Networks in Urban Climate Governance.* In: Cadman, T. (editor). 2013. Climate Change and Global Policy regimes: Towards Institutional Legitimacy. London: Palgrave Macmillan

9.2 Planning documents analyzed

Bangkok. 2007. *Bangkok Metropolitan Administration: Action Plan on Global Warming Mitigation 2007-2012.* Available online at: http://www.mcrit.com/ADJUNTS/ciutats_sostenibles/bangkok2.pdf (Last Access: 26.04.2017)

Chicago. 2008-1. *Chicago Climate Action Plan: Our City, Our Future*. Available online at: http://www.allianceforwaterefficiency.org/uploadedFiles/Resource_Center/Library/water_resources/Chicago-Climate-Action-Plan.pdf (Last access: 26.04.2017)

Chicago. 2008-2. *Adding Green to Urban Design: A City for Us and Future Generations.* Available online at: https://www.cityofchicago.org/dam/city/depts/zlup/Sustainable_Development/Publications/ Green_Urban_Design/GUD_booklet.pdf (Last access: 26.04.2017)

Delhi. 2009. *Climate Change Agenda for Delhi 2009-2012*. Available online at: http://publicity.delhigovt.nic.in/public/eng/publication/climateChange0003.aspx (Last access: 26.04.2017)

Delhi. 2007. *Master Plan for New Delhi – 2021*. Available online at: https://dda.org.in/ddanew/pdf/Planning/reprint%20mpd2021.pdf (Last access: 26.04.2017)

Ho Chi Minh City (HCMC). 2011. *Climate Adaptation Strategy: Moving Towards the Sea with Climate Change Adaptation.* Available online at: http://www.vcaps.org/assets/uploads/files/ HCMC_ClimateAdaptationStrategy_webversie.pdf (Last access: 26.04.2017)

Hong Kong. 2010. *Hong Kong's Climate Change Strategy and Action Agenda.* Available online at: http://www.epd.gov.hk/epd/english/climate_change/files/Climate_Change_Booklet_E.pdf (Last access: 26.04.2017)

Karachi. 2012. *Karachi City Climate Change Adaptation Strategy: A Roadmap.* Available online at: http://www.preventionweb.net/files/27915_100286295karachicityclimatechangead.pdf (Last access: 26.04.2017)

Karachi. 2007. *Karachi Strategic Development Plan 2020.* Available online at: http://www.shehri.org/2020.pdf (Last access: 26.04.2017)

Kolkata. 2015. *Roadmap for Low Carbon and Climate Resilient Kolkata.* Available online at: http://www.kmcclimate.org/assets/doc/Roadmap.pdf (Last access: 26.04.2017)

Lagos. 2012. *Lagos State Climate Change Policy 2012-2014.* Available online at: http://docplayer.net/1523071-Lagos-state-climate-change-policy-2012-2014.html (Last access: 26.04.2017)

London. 2011. *Managing Risks and Increasing Resilience: The Mayor's Climate Change Adaptation Strategy.* Available online at: https://www.london.gov.uk/sites/default/files/ gla_migrate_files_destination/Adaptation-oct11.pdf (Last access: 26.04.2017)

London. 2009. *Rivers Action Plan: A Tool to Help Restore Rivers for People and Nature.* Available online at: http://www.therrc.co.uk/lrap/lplan.pdf (Last access: 26.04.2017)

London. 2012. *Green Infrastructure and Open Environments: The All London Green Grid.* Available online at: https://www.london.gov.uk/sites/default/files/algg_spg_mar2012.pdf (Last access: 26.04.2017)

London. 2016. *The London Plan, Chapter Five: London's Response to Climate Change*. Available online at: https://www.london.gov.uk/sites/default/files/the_london_plan_malp_march_2016_-_chapter_5_-_londons_response_to_climate_change.pdf (Last access: 26.04.2017)

Los Angeles. 2015. *pLAn: Transforming Los Angeles.* Available online at: http://plan.lamayor.org/wp-content/uploads/2017/03/the-plan.pdf (Last access: 26.04.2017)

Maharashtra. 2014. *Assessing Climate Change Vulnerability and Adaptation Strategies for Maharashtra: Maharashtra State Adaptation Action Plan on Climate Change*. Available online at: http://www.moef.gov.in/sites/default/files/Maharashtra%20Climate%20Change%20Final%20Report.pdf (Last access: 26.04.2017)

Mumbai. 2016. *Mumbai Metropolitan Regional Plan 2016-2036*. Available online at: https://mmrda.maharashtra.gov.in/regional-plan (Last access: 26.04.2017)

New York City (NYC). 2007. *PLANYC: A Greener, Greater New York*. Available online on: http://www.nyc.gov/html/planyc/downloads/pdf/publications/full_report_2007.pdf (Last access: 26.04.2017)

New York City (NYC). 2011. *Vision 2020: New York City Comprehensive Waterfront Plan*. Available online at: http://www1.nyc.gov/assets/planning/download/pdf/plans-studies/vision-2020-cwp/vision2020/vision2020_nyc_cwp.pdf (Last access: 26.04.2017)

New York City (NYC). 2013. *PLANYC: A Stronger, More Resilient New* York. Available online at: http://www.nyc.gov/html/sirr/html/report/report.shtml (Last access: 26.04.2017)

Paris. 2007. *Paris Climate Protection Plan: Plan to Combat Global Warming*. Available online at: http://www.energy-cities.eu/IMG/pdf/Paris_climate_protection_plan_2007.pdf (Last access: 26.04.2017)

Philadelphia. 2015. *Growing Stronger: Toward a Climate Ready Philadelphia*. Available online at: https://beta.phila.gov/media/20160504162056/Growing-Stronger-Toward-a-Climate-Ready-Philadelphia.pdf (Last access: 26.04.2017)

Philadelphia. 2010. *Green2015: An Action Plan for the First 500 Acres*. Available online at: https://issuu.com/pennpraxis/docs/green2015_full/91 (Last access: 26.04.2017)

Philadelphia. 2011-1. *Green City, Clean Waters*. Available online at: http://www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf (Last access: 26.04.2017)

Philadelphia. 2011-2. *Green City, Clean Waters: Implementation and Adaptive Management Plan*. Available online at: http://www.phillywatersheds.org/ltcpu/IAMP_body.pdf (Last access: 26.04.2017)

Philadelphia. 2016. *Philadelphia 2035: A City-wide Vision*. Available online at: http://phila2035.org/home-page/city/ (Last access: 26.04.2017)

Rio de Janeiro. 2016. *RioResiliente: Resilience Strategy of the City of Rio de Janeiro*. Available online at: http://lghttp.60358.nexcesscdn.net/8046264/images/page/-/100rc/pdfs/estra_res_rio_ingles_2.pdf (Last access: 26.04.2017)

Singapore. 2008. *Singapore's National Climate Change Strategy*. Available online at: https://www.elaw.org/system/files/Singapore_Full_Version.pdf (Last access: 26.04.2017)

Singapore. 2015. *Sustainable Singapore Blueprint*. Available online at: http://www.mewr.gov.sg/ssb/files/ssb2015-2016_ver.pdf (Last access: 26.04.2017)

Tokyo. 2007. *Tokyo Climate Change Strategy*. Available online at: https://www.kankyo.metro.tokyo.jp/climate/attachement/tokyo-climate-change-strategy_2007.6.1.pdf (Last access: 26.04.2017)

Tokyo. 2008. *Tokyo Metropolitan Environmental Master Plan*. Available online at: https://www.kankyo.metro.tokyo.jp/en/attachement/Master-Plan%28Outline%29.pdf (Last access: 26.04.2017)

Toronto. 2008. *Ahead of the Storm… Preparing Toronto to Climate Change*. Available online at: http://www.climateneeds.umd.edu/reports/Toronto%20City-Preparing%20Toronto%20for%20Climate%20Change.pdf (Last access: 26.04.2017)

Toronto. 2003. *Wet Weather Flow Master Plan – 5 year summary report*. Available online at: https://www1.toronto.ca/city_of_toronto/toronto_water/files/pdf/wwfmp_5yr_implementation_report.pdf (Last access: 26.04.2017)

Toronto. 2007. *Change in the Air: Climate Change, Clean Air and Sustainable Energy Plan*. Available online at: https://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Programs%20for%20Residents/Files/pdf/C/clean_air_action_plan.pdf (Last access: 26.04.2017)

Toronto. 2011. *Toronto's Adaptation Actions: Updated April 2011*. Available online at: https://www1.toronto.ca/City%20Of%20Toronto/Environment%20and%20Energy/Our%20Goals/Files/pdf/toronto_cc_adapt_actions.pdf (Last access: 26.04.2017)

Toronto. 2015. *Toronto Official Plan*. Available online at: http://www1.toronto.ca/planning/chapters1-5.pdf (Last access: 26.04.2017)

Appendix I: Digital Copies of the Analyzed Planning Documents Listed in Chapter 9.2 (CD)