Analytical framework to evaluate the level of integration of climate adaptation and mitigation in cities

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Abstract

Low carbon and climate resilient urban development are becoming important objectives to be achieved in order to assure sustainable urban development pathways. Traditionally, cities have treated climate mitigation and adaptation strategies in isolation, without addressing their potential synergies, conflicts or trade-offs. Recent studies have shown that this can lead to inefficiencies in urban planning, conflicting policy objectives and lost opportunities for synergistic actions. However, in the last few years we have observed that cities are increasingly moving towards addressing both mitigation and adaptation in urban planning. Cities need to pay particular attention and understand the rationale of both policy objectives while considering integration of the two policies in urban planning and decision-making. This study presents the development of an analytical framework to evaluate the level of integration of climate mitigation and adaptation in cities' local climate action plans. We tested this framework in 9 selected major cities, representatives from all continents, which are frontrunners in climate action both in their regions and globally. We applied the framework in order to evaluate the level of mitigation and adaptation integration in cities' CCAPs and further explore the different types of mitigation – adaptation interrelationships that have been considered. We also devised a scoring system in order to be able to compare and rank the different CCAPs regarding their level of integration of adaptation and mitigation. The paper draws good practices to support cities in developing climate change action plans in an integrated way.

1. Introduction

Whilst being centres of social innovation and economic development, cities globally are major contributors to greenhouse gas emissions (GHGs). It is estimated that between 60 and 80 % of global energy consumption originates from cities and their associated activities, with consumption of fossil fuels for energy and transport generating almost three quarters of all human-induced GHGs (UN Habitat,

2011). Additionally, with large accumulations of inhabitants, technology, infrastructure and economic assets, cities are also more vulnerable to climate change impacts such as extreme temperatures, flooding, droughts and intense storms (The World Bank, 2010). At the same time, cities aspire to be part of the solution too, putting their names on the global map through emerging networks, peer to peer learning and technological innovation tackling climate change (Pattberg and Widerberg, 2015). Within the variety of actions that can be taken, it is worth defining and distinguishing mitigation, aiming to reduce the emissions from anthropogenic activities (such as transportation, energy production, industry and agriculture and infrastructure construction) and adaptation, aiming to reduce in the short and middle terms urban vulnerability to climate threats. Since both policies aim to address different types of climate change impacts, also the characteristics of the adaptation and mitigation actions on the ground differ greatly (as synthesized in table 1). However, with carbon concentrations in the atmosphere rising to irreversible levels that cannot be stabilized with current mitigation targets, both types of measures need to be implemented simultaneously in order to ensure we address climate change systematically and effectively (Klein et al., 2007). Integration of climate change adaptation and mitigation planning and action is critical to ensure that the two efforts are mutually reinforcing, to realise synergistic efficiencies, to maximize the impact of limited city resources and to minimise any potential conflicts that could lead either to mal-adaptation or mal-mitigation. While there is growing interest in and encouragement of integration, it remains challenging for cities to identify issues and opportunities in integration and to know what the drivers behind decision-making approaches and implementation mechanisms of the two policies are. More understanding of these are needed to ensure that effective integration that would maximise the synergies and minimize the conflicts of adaptation and mitigation takes place.

Table1: Differences between adaptation and mitigation policies (adapted from Dang et al., 2003)

When compared to international and national institutions, local governments and cities are increasingly becoming emerging global climate governors (Gordon and Acuto, 2015), also through a more direct governance structures (Bulkeley, H. and Betsill, 2003). Whereas many cities now develop and publish Climate Change Action Plans (hereafter referred to as CCAPs) the majority remain focused on mitigation actions. In 2014, Reckien et al. evaluated 200 large and medium sized city CCAPs in Europe and found out that 35% of the sample have no mitigation plan, whereas 72% have no adaptation plan. It should be stated here though, that often climate adaptation actions are included in disaster risk reduction and management plans but are not necessarily called as such.

Furthermore, different studies show that mitigation actions receive the main portion of the global climate finance by international multilateral development aid organizations and development banks. Between 2010 and 2011, 96% of available funding was allocated to these activities (Buchner et al., 2012; Schwarze et al. 2018). Reasons for this could originate from past focus of the political processes such as the UNFCCC, where mitigation was the key policy to address climate change (Grafakos et al., 2018). More funding is required for adaptation methods to ensure both climate adaptation and mitigation are addressed appropriately. This is especially important to vulnerable developing countries (Duguma et al., 2014). The gradual policy shift towards adaptation can be also observed in the international climate policy debate, particularly regarding discussions on climate finance, vulnerability and the Loss and Damage debate (IISD, 2012; Mechler et al. 2019; Mechler and Schinko, 2017.). In addition, there is a recent trend where national and local governments are developing climate adaptation action plans, or

combining adaptation and mitigation (Ad/Mit) policy objectives in an integrated climate change action plan (Duguma et al., 2015; Aylet, 2015).

An increasing number of cities, within Europe and globally, are slowly shifting from addressing adaptation and mitigation separately towards combining these policies. Aylett (2015), based on an extensive survey of 350 local governments' plans globally addressing climate change, found out that 39% of the plans address both policies whereas, Reckien et al., (2014), based on the review of 200 European CCAPs found out that 21% of them integrate the two policies. A more recent study by Reckien et al., (2018) shows that out of 885 urban CCAPs reviewed in Europe, 153 CCAPs (17%) combine adaptation and mitigation.

Climate change adaptation and mitigation measures are interrelated – in some cases positively (synergies), in others negatively (conflicts) – and sometimes decisions on implementation are based on difficult trade-offs, thus necessitating choices between conflicting policy and planning goals (Klein et al., 2007). Indeed, if addressed as stand-alone policy goals, adaptation (building resilience) and mitigation (sustainable energy transformation) strategies could lead to trade-offs or unexpected conflicts (Chelleri et al., 2015), where one action focusing on adaptation could hinder the progress of the mitigation action or vice versa (Klein et al., 2007). For example, tackling water scarcity through a desalination plant could drive the lock-in of the city to increased energy consumption (adaptation at the expense of mitigation), or recent investments in North African transnational long term projects based on concentrated solar power plants (requiring up to 3,500 liters per Megawatt hour generated) could contribute to water scarcity in arid territories (mitigation action on expense of adaptation) (Chelleri et al, 2014).

For the purposes of this study, a *co-benefit* occurs when a plan, policy or measure that aims to enhance an adaptation (mitigation) objective, leads simultaneously to the enhancement of mitigation (adaptation) objective. A *synergy* is understood as an interaction between an adaptation and a mitigation plan, policy, strategy, or practical measure that produces an effect greater than the constituent components. A *conflict* is a plan, policy, or measure that counteracts or undermines one or more planning goals between adaptation and mitigation. A *trade-off* is a situation that necessitates choosing (balancing) between one or more desirable, but sometimes conflicting, plans, policies, or measures.

Table 2: Illustrative examples of adaptation and mitigation interrelationships

There are many advantages for a combined consideration of adaptation and mitigation, especially at the local level where benefits are more visible, since cities should prepare for current extreme weather events, whilst also reducing long-term climate change impacts (Grafakos et al., 2018). Economically, integrating both measures can be beneficial, if they are improving the cost-effectiveness of planning (Schwarze et al., 2018) and reducing resource competition (Tol, 2005), for instance. Combining the measures is difficult due to the numerous stakeholders and sectors involved in planning, decision making and implementation of actions (McEvoy et al. 2006*)*. However the dual consideration helps identify potential maladaptation or mal-mitigation or conflicts between specific plans, which also allows for further reflection of cross-sectoral plans (Barnett and O'Neill, 2010). Additionally, this allows a consolidation of holistic understanding compared to separate policies and sectorial decision making (Grafakos et al., 2018).

Where there are many advantages of simultaneously considering both climate adaptation and mitigation, there are few studies that have explored and identified the different types of interrelationships between the two policies in urban areas. Landauer et al. (2015), based on an extensive literature review, identified interrelationships (synergies and conflicts) of adaptation and mitigation measures at different levels in urban planning, such as policy and organisational levels. The paper also reviewed common synergies and conflicts that occur in specific sectors including energy, building and infrastructure solutions. Demuzdere et al., (2014), based on empirical evidence identified the most common co-benefits and trade-offs between adaptation and mitigation services provided by green urban infrastructure. Duguma et al. (2014) developed an analytical framework to assess the enabling conditions for synergies at the national level and applied it to developing countries to explore the potential that these countries have toward addressing the synergies of adaptation and mitigation policies. A more recent study by Landauer et al., (2018) discussed how different scales drive interactions of adaptation and mitigation in cities.

Aim of the study

Where there are only few studies addressing adaptation and mitigation interrelationships at the city level, at present there is a lack of systematic approach, or framework, to evaluate the level at which adaptation and mitigation are being integrated into cities' CCAPs in order to maximize synergies and avoid conflicts and find a balance between the two policy objectives. Such a framework is useful to improve both urban planning and governance effectiveness (Landauer et al., 2015), especially due to scale differences of policy implementation (Landauer et al. 2018).

This paper bridges the gap by presenting a framework, including a scoring system, to identify and evaluate the level of integration of adaptation and mitigation (Ad/Mit) in cities' climate action plans. The Ad/Mit framework has been developed by means of a review of relevant academic literature on climate change action planning and various CCAPs globally. Of these plans we have selected nine to evaluate in-depth, on how the plans integrate adaptation and mitigation, and at which level. Furthermore, we make the hypothesis that cities that have been engaged in climate change planning for some time achieve higher levels of integration of adaptation and mitigation. To investigate this, a short desk study was completed to identify when each city's first CCAP was published.

2. Analytical framework to evaluate the level of integration of adaptation and mitigation in CCAPs

There are three main stages in urban climate planning (Moser and Ekstrom, 2010; Bizikova et al., 2011; Grafakos et al., 2018): i) identifying and understanding stage, ii) envisioning and planning stage, and iii) implementation, management and monitoring stage.

Identifying and Understanding

Sufficiently disaggregated city-level and, whenever possible, metropolitan-level *GHG emissions profiles or inventories* are the starting point for climate mitigation planning through characterization of emissions, adequate sectoral breakdown at both municipal and community level (Sippel, 2011; Millard-Ball, A., 2012)

For adaptation planning, *vulnerability profiles* through maps and indicators at appropriate spatial scales

allow the identification of climate risk probabilities, taking into account vulnerability factors such as exposure, sensitivity, and adaptive capacity.

Forecast of future emissions and *future climate impacts* also require consideration of the current and projected future growth of multiple urban sectors; the level of carbon emissions of these sectors and an estimation of the probabilities of risk outcomes and damage costs throughout the city.

Uncertainty of future climate impacts at the city level is one of the main challenges that municipal governments must address. *Climate hazards* are often differentiated according to their temporal scale: (1) extreme events (immediate and short term) such as floods, heat waves, landslides, and storm surges and (2) long-term (annual/decadal) climate threats such as variations in average temperature or other slow-onset events such as sea level rise.

Envisioning and Planning

Policy makers and urban planners need to set *specific goals and targets* based on the policy objectives for adaptation and mitigation. This can be particularly challenging with regard to the difference in spatial and temporal scales of adaptation and mitigation planning and implementation (Moser, 2012; Landauer et al. 2018). Often cities set long term emissions reduction targets up to 2030 or even 2050, disaggregated in different urban sectors.

An important step in planning for climate change is the Identification of different adaptation and mitigation measures or different portfolios (combinations) of measures, considering possible alternative pathways for meeting cities' climate-resilience and low-carbon development objectives (Klein et al., 2007). Mitigation and adaptation actions (or portfolios of actions) are assessed against their costs and benefits or by multiple objectives and criteria, whereas trade-offs between different objectives can be also identified and assessed, a process often called prioritization (Grafakos et al., 2018).

Assessment and prioritization methods such as economics-based approaches, including cost-benefit analysis and cost-effectiveness analysis can be applied (Cartwright et al., 2013, Gouldson et al., 2015), as well as integrated approaches such as multi-criteria analysis and integrated modelling (Haque et al., 2012; Walsh et al., 2013; Scrieciu et al., 2014; Grafakos et al., 2016); and sectoral approaches (Charoenkit and Kumar, 2014).

Furthermore, *coordination* of the plan development and implementation is important and can vary from setting a common coordination body to allowing different departments to collaborate and implement the plan. *Communication* of the plan is also important which often takes the form of information or public education campaigns (Burch 2010a).

Management and Monitoring

Implementation of different climate change actions (particularly the structural ones) can be *costly*, therefore a clear budget allocation for financing climate actions is imperative for implementation (Schwartze et al., 2018). Since financing adaptation actions could be competing with financing mitigation actions, the establishment of a common budget or funding body could be an efficient way to best allocate existing budgets.

Institutional and jurisdictional divergences between adaptation and mitigation measures can become obstacles to an integrated climate policy approach (Tompkins and Adger, 2005; Landauer et al. 2018).

Therefore, *common policy or regulatory framework* could enhance integration of adaptation and mitigation. Moreover, a *common implementation body* could also ensure more efficient combined implementation of adaptation and mitigation actions (Shaw et al., 2014).

Implementing both adaptation and mitigation actions requires the involvement of a range of institutions and departments but also the creation of *partnerships* with different *urban actors and stakeholders* such as civic society and the private sector (Burch, 2010b; Broto and Bulkeley, 2013).

Mainstreaming climate actions into existing plans (e.g., sectoral plans, development plans) can help to ensure proper implementation and accountability (Swart and Raes, 2007).

Monitoring and evaluation systems track and evaluate results before, during, and after implementation, enabling improvements and modifications through feedback processes. In this stage, the level of achievement of the climate change adaptation and mitigation objectives is measured through information and data collection for monitoring and evaluation (Brown et al., 2016; Grafakos et al., 2018).

Figure 1: Stages of integrated urban climate change planning (Grafakos et al., 2018)

3. Methodology

In this study, nine (9) urban CCAPs were reviewed and their content was analysed thoroughly. All inhabited continents are represented by at least one action plan, as synthesized in Table 3. Of these plans, six combined both, adaptation and mitigation, while two primarily focused on adaptation (Durban and Vancouver) and one focused primarily on mitigation (Paris). CCAPs were considered appropriate secondary data for this study as they are (a) comprehensive local-level documents addressing climate change issues; (b) documents that are globally and straightforwardly comparative; (c) official documents prepared by the responsible bodies for addressing climate change within a specific city. Of the CCAPs analysed, seven were in English, and two were in Spanish. Table 3 provides background information regarding the selected CCAPs that were analysed. The selection criteria were as follows: i) Major cities, ii) “frontrunner” or “model” cities globally or regionally, with regard to experience on local climate change action planning and iii) addressing both adaptation and mitigation in their CCAPs, even if the primary focus is either on adaptation (e.g. Vancouver) or mitigation (e.g. Paris).

Table 3: Selected urban Climate Change Action Plans reviewed in the study (in alphabetical order)

Based on a desktop study, the CCAPs were reviewed and their content was analysed and evaluated by applying the analytical framework developed for the purpose of this study. The integrated planning process for climate change in the cities was operationalized in 3 different stages and associated

variables in order to assess the level of integration of Ad/Mit. Indicators were specified to allow us to gauge whether the selected variables were considered in the three planning stages.

Each variable from the three planning stages can be found in Table 4. For most variables, responses were in binary form - if an indicator was fulfilled, the CCAP was given a score of 1, and otherwise the CCAP received a 0. Furthermore, seven (7) variables were based upon a scoring scale of 0-2 as these indicators did not return yes/no responses. Appendix 1 illustrates how the variables "GHG emissions forecast", "Vulnerability profile", "Future climate projections", "GHG emissions reduction targets", "Consideration of Ad/Mit interrelationships", "Mainstreaming of both Ad/Mit actions" and "Common Monitoring procedure/framework" were scored.

Table 4: Variables used to assess the level of integration of climate adaptation and mitigation in CCAPs

Furthermore, we investigated whether a CCAP has explicitly stated synergies or conflicts between Ad/Mit within the plan and identified the sectors that the interactions have occurred.

Whereas the aim of this paper is to consider urban CCAPs as a whole and not to compare one against the other, good CCAP practices are highlighted with examples from the selected plans. Furthermore, the framework can be used to compare CCAPs regarding the level of integration of adaptation and mitigation in the planning process.

4. Results and Discussion

4.1 Identifying and Understanding

The results regarding the variables of "GHG emission profiles", "GHG emissions forecast" that focus on mitigation and "vulnerability profile" and "future climate projections" that focus on adaptation are displayed in Figure 2[1]. Furthermore, the variables that reflect a combine approach such as "Both emissions profile and vulnerability profile" and "Both emissions forecast and climate projections" are also depicted in the same figure.

As can be seen from Figure 2, all nine CCAPs of the selected cities contain long term climate projections, in a simple or more sophisticated way. Even the CCAP of Paris, which mainly focuses on climate mitigation, presents some future climate projections. In Durban the CCAP discusses the expected temperature and precipitation increases up to 2100, and Vancouver's CCAP provides an appendix detailing climate model projections to a 1961-1990 baseline for 2050 and 2080.

Additionally, all combined and mitigation focused CCAPs include a GHG emission profile until the year of publishing the report. However, out of these nine action plans, only Chicago, Montevideo, Mexico City and Bangkok advanced further to discuss the forecast of emissions in a 'business-as-usual' scenario at any time span, with Chicago stating that GHG emissions would increase by 35% in 2050 and Mexico City

[1] All graphs are colour coded. Blue color bars represent standalone mitigation variables, red color bars represent adaptation variables, green color bars represent variables that reflect integration of mitigation and adaptation and grey color bars represent variables applicable to adaptation and mitigation.

predicting a linear projection to the midterm date of 2025.

Figure 2: Frequency of selected variables found in the CCAPs within Identifying and Understanding stage

When considering the vulnerability profiles, Durban raised the threats to the city in a structured manner within a chapter on “Projected changes in Durban’s climate and associated impacts”. Vancouver also provided a coherent vulnerability and risk assessment within its second appendix. The CCAP of Paris provided detailed information of its city’s vulnerability although the focus was mainly on mitigation.

It was also interesting to consider which cities identified and measured both mitigation and adaptation related factors for their action plans. As can be seen in Figure 2, six cities have conducted and included in their CCAP both a GHG emissions and vulnerability assessments. It was less common (3 out of 9) though for a CCAP to include a GHG emissions forecasting and future climate projections. Mexico City, Montevideo and Chicago included both of types of information.

4.2 Envisioning and Planning

From the eight variables considered within the envisioning and planning stage, the five that are related to target setting, prioritization and communication can be seen in Figure 3. An obvious observation from this graph is the low number of CCAPs containing cost estimates to implement the actions stated in the plans. It is reasonable to assume that costs for these actions have been considered and calculated, as costs of action implementation are often important criteria within decision-support assessments. Therefore, it appears that this information has been purposely excluded.

For our research questions, the most important variables to consider are “Consideration of both adaptation and mitigation actions” and “Adaptation and mitigation interrelationships considered”. All CCAPs do refer to both actions to combat GHG emissions and reduce vulnerability for climate change, however mitigation actions appear far more frequently than adaptation actions. Furthermore, 7 out of 9 CCAPs include both GHG emissions reduction targets and adaptation objectives. For example, in the Chicago Climate Action Plan, out of 35 actions to address the challenge of climate change, 26 actions are focusing on mitigation (in sectors such as energy efficient buildings, improved transportation, clean energy sources and reductions of pollution), and only 9 actions are focusing on adaptation.

Figure 3: Frequency of selected variables found in the CCAPs within Envisioning and Planning stage

Furthermore, of the nine CCAPs, six explicitly state interrelationships between adaptation and mitigation, with Paris, Seoul and Mexico City being the only CCAPs to not explicitly state any interrelationships. Montevideo's CCAP contains an entire chapter on transversal actions fostering adaptation and mitigation integration and the adoption of the plan within the metropolitan region. The types of interrelationships are presented and the sectors are discussed in detail in section 3.5. Lastly, seven out of nine CCAPs state a common public education, outreach programme.

4.3 Implementation and Monitoring

Figure 4 presents all variables used to assess the level of integration in the CCAPs related to financing, implementation and monitoring. From the variables, only two are considered stand-alone – financing commitment and partnerships. From the graph, it can be seen that some variables have been more widely considered than others. For example, all CCAPs have a partnership in some fashion; whether this is with a private organisation, international initiatives or other city governments nationally and internationally. Additionally, all cities except Wellington and Montevideo have set up common monitoring frameworks to observe and evaluate. Wellington's action plan only states monitoring of the results of mitigation actions.

Figure 4: Frequency of selected variables found in the CCAPs within Implementation and Monitoring stage

However, other aspects have not been considered with both mitigation and adaptation in mind. Mainstreaming is discussed in all CCAPs, however potential for both mitigation and adaptation mainstreaming was identified in five CCAPs. Based on this outcome it seems that although CCAPs are stand-alone plans, the cities under review realise the importance of mainstreaming for effective and efficient implementation. For example, Paris discusses how the Climate Action Plan, particularly the adaptation related measures, can be linked to other municipal action such as the Biodiversity plan, however we cannot infer from the CCAP, if mitigation actions are also being considered for mainstreaming.

Finance related topics again are rarely stated at all, with only Seoul confirming a precise financial commitment to their actions. Wellington and Vancouver have raised that elements of their plans have been budgeting for, but there is no confirmation of whether this money is being allocated. Within Durban's CCAP, there is currently no funding available and the plan has the aim to find financial backing for the implementation of its key priorities. Common funding bodies appear to be also rarely established. Montevideo's plan states that each department should begin working on short term projects within their own budget where longer projects will depend on external funding from governmental or investors' capital.

Another variable that was found relatively frequently (5 times) was the common coordination or implementation body. Whereas the CCAPs may detail both mitigation and adaptation actions, different sectors are often responsible for different goals. For example, in Durban, although the strategy will be led by the eThekwini Municipality's Energy Office and the Environmental Planning and Climate Protection Department, a broad range of implementers and stakeholders will carry out the plans, such

as other local authorities, local businesses and community based organisations. While these stakeholders can concentrate fully on their sections of the action plan, it becomes increasingly difficult to monitor and evaluate progress during the implementation and actions from one organisation could unintentionally conflict with other arrangements. As it can be seen in figure 4, five of the CCAPs state a common (Ad/Mit) coordination/implementation body.

As the results indicate, the majority of the CCAPs do provide common (Ad/Mit) monitoring procedures, however with many stakeholders being involved in the plan and little quantification on the level of integration in the reports regarding would be successful outcomes of the various aims, it will be difficult to analyse and evaluate success in these action plans.

4.5 Main adaptation-mitigation interrelationships identified

Within the action plans, there are certain sectors where synergy (or co-benefit) type of interrelationships were frequently identified and stated, including:

Urban Greening

- Green roofs cooling the city as temperatures rise could retain water during storms, contributing to building climate resilience through a decentralized water management paradigm, while increasing energy efficiency of buildings. [Climate Change Adaptation Strategy, Vancouver]
- Whilst enhancing forest sinks can increase carbon sequestration, it also helps the city meet objectives on biodiversity protection and will reduce groundwater runoff when rainfall increases. [Wellington City's 2013 Climate Change Action Plan]

Urban agriculture

- Encouraging local, innovative food production using sustainable farming practices allows a city to provide for communities affected by natural disasters. Additionally, transporting this food will convey a lower carbon footprint. [Durban Climate Change Strategy]
- Promoting sustainable farming also allows for the soils in the region to sequester more Carbon Dioxide from the environment [Plan Climático de la Región Metropolitana de Uruguay]

Water management

- With the increase of extreme heat in summer and also growing flooding risks causing polluted bodies of water, Chicago aims to make sure buildings and inhabitants use water wisely. Retrofitting buildings will increase water efficiency in addition to reducing energy use for pumping, heating and distributing the water. [Chicago Climate Action Plan]

Annex 3 lists all interrelationships that were identified in the nine analysed CCAPs. Furthermore, additional co-benefits related to economic gains, quality of life and public health are also raised within the CCAPs, at times more frequently than the co-benefits between adaptation and mitigation actions. Another topic to raise regarding the interrelationships is that Durban is the only CCAP that refers to *trade-offs* or *conflicts* between adaptation and mitigation actions, stating "It should be noted that some of the themes in the Strategy are not always mutually supportive, with some responses that may be appropriate for a specific theme negatively impacting the objectives of a different theme." From the

explicitly stated interrelationships in all 9 CCAPs, only Durban mentions a trade-off between mitigation and adaptation, relating to localised energy generation and the potential increase of air pollution in the city. In a similar fashion to the absence of related costs, the CCAPs appear to conceal valuable, yet undesirable information to present a wholly progressive action plan.

There are also instances where with knowledge on the sector and evidence from other cases, potential *synergies* can be identified, which have not been stated within the CCAPs. An example of this is conversions to multiple renewable energy power plants in Chicago and Paris, reducing GHG emissions and dependency on a single energy source. Many of the synergy and conflict examples from Landauer et al., (2015) study could have also been incorporated into the CCAPs. In another example, Paris' CCAP states that the city intends to maintain its high urban density. Whereas this reduces the energy use from transport, this can result in a need for more air condition and reductions in green and blue space in the urban environment. Identifying these "implied" co-benefits and conflicts is beyond the scope of this study. However, it is important to highlight here that identifying co-benefits and conflicts is a demanding task that requires very specialised type of technical capacity, which cities' officials do not necessarily have.

When considering the CCAP sample, Seoul's CCAP looks quite different from the rest regarding action detail and explanation. In total, the CCAP lists 160 actions to combat climate change in five different sectors, with an almost even split between adaptation and mitigation actions. However, the Seoul CCAP provides no descriptions of how the actions will be implemented, or whether the action is aiming to reduce emissions or increase resilience, making it difficult to detect or imply interrelations on one hand and monitor their implementation on the other.

4.6 Final scoring of CCAPs

Apart from assessing the frequency of each variable in the CCAPs under investigation, we also estimated the final score of each CCAP according to the scoring system we devised. The aim of the scoring is not to compare which CCAP is "better" than the other, but to provide insights about the level of integration of Ad/Mit in CCAPs.

Figure 5: Final scores of CCAPs regarding the level of integration of Ad/Mit

Mexico City achieved the highest score (23) of integration Ad/Mit of all CCAPs, and scored very high in all 3 stages of climate change planning cycle. Chicago and Wellington scored also highly with a good balance and integration of adaptation and mitigation in their CCAPs. Paris' CCAP although is mitigation driven, scored also relatively high (17). Vancouver's CCAP, although adaptation driven, scored 16 which is a very high score considering the CCAP's focus. These two CCAPs clearly demonstrate that even when the primary focus of a CCAP is either on adaptation or mitigation, a level of integration can still be achieved. Seoul scored low as the CCAP kept adaptation and mitigation actions separated and stand-alone. As stated, a low score does not represent a bad CCAP in terms of quality or content, instead the score provides insight on the level of integration of adaptation and mitigation.

Table 5: CCAP release dates and their associated evaluation scores

Regarding our hypothesis that cities with longer engagement in climate change planning, achieve higher level of integration, the hypothesis stands true for Mexico City and Wellington, whose first CCAP was published six years before their current reports, but it is contradicted by Seoul whose first CCAP was released in 2009. A large CCAPs study would need to be analysed to test this hypothesis.

The scoring system presented here could be used as a comparative metric on the level of Ad/Mit integration between CCAPs. Moreover, it could be applied as a benchmark to compare a city's CCAP with an "ideal" CCAP that maximises the level of integration of adaptation and mitigation policies. The cities can assess the level of integration of their CCAP and include interrelationships to move towards a more integrated climate change action planning process. However, it should be clarified here that integrating adaptation and mitigation might be challenging in different policy contexts and scales in different cities (Landauer, et al., 2018). Therefore, the proposed assessment framework and scoring system is not prescriptive but more supportive to cities that want to measure their level of integration of Ad/Mit and move towards a more integrative planning approach. Furthermore, do high levels of integration of adaptation and mitigation in a CCAPs also lead to a more efficient implementation of climate change actions "on the ground"? This is another research direction that merits further attention. There is some evidence that interactions of Ad/Mit actions in cities occur and cut across specific sectors, but more extensive studies are needed to shed light on that issue.

By using the proposed evaluation framework, comprehensive reviews still need to be undertaken to even larger number of CCAPs and similar analysis and evaluation could be conducted in other regions to get more insights on how and to which extend cities integrate adaptation and mitigation in their CCAPs. Also, there is a need for further research on the drivers and barriers of integrating Adaptation and Mitigation, and further understanding the correlation between the level of integration with other variables such as city's GDP, level of GHG emissions, membership in city networks, number of years active in climate change action planning, level of capacity and others. Both quantitative, based on extensive surveys, and qualitative analyses based on in-depth interviews, could address the aforementioned research issues. In addition, the quantification of interactions (synergies and trade-offs) of adaptation and mitigation measures and policies is a research field that could potentially provide essential support to urban decision makers, urban managers and practitioners. In particular, cost related methods such as cost-benefit and cost-effectiveness analyses could be extended to include and analyse interactions of adaptation and mitigation actions. Multi-criteria evaluation and nexus studies could be also employed to quantify Ad/Mit interactions (Grafakos et al., 2016; Valek et al., 2017).

5. Concluding remarks

Traditionally adaptation and mitigation both at the national and local level of governance have been addressed separately, but recently a shift towards more integrative approaches has been observed. To a large extent, local governments lack the necessary institutional, jurisdictional and financial capacity to integrate adaptation and mitigation in their climate change action plans. Furthermore, there has been a

lack of a systematic assessment framework to evaluate the level of integration of Ad/Mit in cities' CCAPs. Our attempt was to bridge this gap by developing an assessment framework and an associated scoring system to evaluate 9 CCAPs of cities that are frontrunners in climate change action planning. This is not a prescriptive framework, but it can support cities that need to employ an integrated approach in climate change action planning. The proposed framework operationalizes an integrated climate change planning process in different stages and variables that further lead to scoring of CCAPs' level of Ad/Mit integration. Additionally, it was found that Urban greening, water management, urban agriculture, energy, air quality management are the main urban sectors where Ad/Mit interactions occur. None of the CCAPs included any level of quantification of interactions of Ad/Mit indicating a capacity gap in cities, which can be eventually bridged by the development and utilization of quantification techniques. This paper aims to trigger further discussion and research on the opportunities and challenges of integrating adaptation and mitigation in climate change action planning and implementation. It also aims to support local governments on identifying the main aspects of better integration of adaptation and mitigation in their CCAPs.

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Annex 1: Scoring system

Annex 2: Table of selected CCAPs and their sources

Annex 3: List of Identified interrelationships in CCAPs