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Integrating mitigation and adaptation in urban climate change action plans in Europe:
A systematic assessment

1. Introduction

Preventing dangerous climate change will require immediate and effective action to mitigate greenhouse gas emissions [1]. At the same time, due to the volume of emissions already released into the atmosphere and the long timescales over which these emissions affect the climate, adaptation actions will be necessary to manage the risks of this committed climate change [2] .

Globally, cities have emerged as leading climate change adaptation and mitigation actors, reflecting both a shift towards a more bottom-up approach to climate action (as seen in the Paris Agreement) and the unique capacities of urban policymakers to implement climate policies [3; Reckien et al., 2014; 2018]. For example, in 2018, nearly 8,000 urban areas and other local and regional administrations from every continent (excluding Antarctica), representing almost 10% of the global population, had set GHG emissions reduction targets for their local territories [4]. Likewise, scholarly literature shows that globally adaptation efforts are increasing [Araos et al., 2016], in particular in large and economically strong cities [Reckien et al., 2015]. Climate adaptation is defined as “the process of adjustment to actual or expected climate and its effects” while mitigation is defined as “a human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs)” [1].
Finding ways to integrate these two dimensions of climate policy may provide far-reaching benefits [5], especially in cities [1, 6], with the potential of enhancing synergies and reducing conflicts. The latter can lead to more cost-efficient outcomes, and avoid maladaptation (the “problem of increasing risks from adaptation” [7, p211]) as well as malmitigation (i.e. increasing risks from mitigation)8[7]. Furthermore, sources of funding can be collated, knowledge can be consolidated, and more holistic, systems-based approaches can be implemented [9]. Realising these benefits requires a better understanding of the progress that urban areas may have made in integrating climate actions [10]. Previous research has shown that cities have started to take actions towards a more integrated approach in climate change planning [11, 12, 13], although only a minority of cities' action plans considered both climate policies and even fewer implement integrated adaptation and mitigation plans [14].

To redress this knowledge gap, this study reviews and evaluates 147 CCAPs from a sample of 885 cities in Europe [7, 49]. This sample is regionally representative according to population shares across European countries and covers both large and medium-sized cities. Of these cities, 147 cities (17%) were identified as having undertaken both adaptation and mitigation planning in a joint manner. Of the other 738 cities, 62 (7%) had separate adaptation and mitigation plans and 376 (42%) had only a mitigation plan giving a total of 586 cities (66%), with a mitigation plan. Only12 cities (1%) had only an adaptation plan a total of 226 cities (26%), with an adaptation

plan., 288 (33%) lacked any form of stand-alone local climate plan [7]. Reckien et al. [7] identify a number of potential drivers of developing and integrating local climate plans, such as national level policies (for both developing and integrating plans) and membership of international climate networks (for developing plans, however not necessarily a driver for integration), but did not go deeper into levels of integration of adaptation and mitigation or the potential drivers, barriers, advantages and drawbacks of an integration of mitigation and adaptation efforts.

Following up on this line of research, this study 1) evaluates the level of integration of adaptation and mitigation in local Climate Change Action Plans (CCAPs) in Europe; 2) identifies the synergies and co-benefits of integration of adaptation and mitigation; and, 3) distils best practices for other municipalities.

Following this introduction, Section 2 explores the existing literature on the integration of mitigation and adaptation planning in the urban context. Section 3 describes the evaluation framework presenting how an integration index and a scoring system have been constructed. Section 4 presents the results and Section 5 discusses them in the broader context of the relevant literature. Section 6 summarizes the main findings and conclusions.

2. Literature review

Integrated mitigation and adaptation planning shifted from national [16, 17, 18] to local planning in the early 2000s [15] following evidence of significant synergies between different climate action approaches [19, 20, 10]. These studies established the scale and importance of synergies and possible conflicts and trade-offs between adaptation and mitigation measures. In addition, these studies suggested that urban policymakers can maximise positive synergies and minimize conflicts in climate action planningby involving the widest range of stakeholders in decision-making processes and by developing methodologies to enable the comprehensive inclusion of complementary strategies for climate change action.

Local authorities are increasingly developing and adopting local climate plans (Reckien et al., 2014, 2018), often with the support of partnerships from different sectors and multiple governance levels [25, 26, 24]. Local authorities and cities are highly vulnerable to climate impacts, for example slow-onset events such as sea-level rise, and extreme events such as storm surges, flash floods, and heat waves, which are in turn causing increased costs, health impacts and reduced well-being [21, 22, 23]. At the same time theys of GHG emissions. Both aspects make cities play a central role in local climate adaptation and mitigation planning [24, 8]. In comparison to rural areas, urban areas are often in greater need of adaptation actions due to the concentration of population and their greater reliance on urban infrastructure systems, which call for an improved understanding of the best adaptation measures in response to climate risks [19, 27].

There is a growing number of local climate and sustainability initiatives, for instance, the Local Governments for Sustainability (ICLEI), which represent more than 25% of global urban population [28], and the Cities for Climate Protection Campaign (CCPC) both act to reduce and offset GHG emissions through research and development of best practices, and sharing experiences between cities. The C40 Cities Climate Leadership Group [29] brings together more

than 100 of the world's largest cities. Initiatives have also been taken at the European level with the European Union's (EU) Covenant of Mayors for Climate and Energy, which accounts for 7,755 signatories as of ….., andcities having an action plan submitted [30]. In January 2017, the Global Covenant of Mayors for Climate & Energy formally brought together the EU Covenant of Mayors and the Compact of Mayors – the world's two largest initiatives of cities and local governments – to advance city-level transition to a low emission and climate resilient economy, and to demonstrate the global impact of local action [30]. Furthermore, the Rockefeller Foundation has launched the Climate and Resilience Initiative and the 100 Resilient Cities Network in support of the most vulnerable communities via global-reaching funding schemes, capacity building and advanced resilience solutions [31]. As cities try to balance their efforts to develop both mitigation and adaptation actions and plans, a need for guidance on how to move towards a more integrated approach is needed.

Several studies have investigated the urban GHG emissions reduction potential (as mitigation) in different sectors [25, 32;] , and/or the potential to decrease the urban climate vulnerability and impacts for human and environmental systems (as adaptation) [2, 7]. A study on 885 European cities found that 147 cities (16.6%), considered both adaptation and mitigation policy objectives in their CCAPs [7]. A similar study of 20 CCAPs from US municipalities found that mitigation discourses prevailed over adaptation strategies to tackle climate challenges [25]. However, this study did not consider the integration and interactions of adaptation and mitigation in cities' climate action planning.

Although an increasing number of studies focus on the review of CCAPs with a focus on different aspects of climate change planning in cities, such as on climate change actions in Europe [33, 8, 5, 7], adaptation strategies [34, 2], GHG emissions reduction strategies [32, 35], and ecosystem services [36, 37], most studies continue to analyse mitigation and adaptation In addition, there is a lack of a comprehensive and systematic CCAPs analysis investigating the level of integration and interrelationships of adaptation and mitigation policy objectives [19, 39, 40].

Grafakos and colleagues [41] developed an evaluation framework of variables and a scoring system in relation to mitigation-adaptation the identifying and understanding stage, ii) the envisioning and planning stage, and iii) the implementation and monitoring stage. The framework was tested in a small number of global cities (9) emphasizing the need for broader application of the evaluation framework in order to assess and compare the level of integration of adaptation and mitigation in different cities' CCAPs.

The analysis of interrelationships within European integrated CCAPs constitutes the earlier literature defines interrelationshipsindistinctively [14], the current study distinguishes instead between positive (co-benefits and synergies) and negative (conflicts and trade-offs) interrelationships. A *co-benefit* occurs when an adaptation (or mitigation) action leads to positive mitigation (or adaptation) effects, or vice versa. For instance, effective building envelopes that aim to reduce energy use and GHGs (mitigation) maylead to better insulation and improved indoor temperature comfort during warmer temperatures (adaptation co-benefit). In the context of this study, s*ynergy* occurs when an urban action that is not primarily aimed at either adaptation or

mitigation (it could be aimed at both, or neither) leads to the simultaneous achievement of both mitigation and adaptation.. An example of synergy relates to planting trees in urban areas, which can act as a carbon sink (mitigation benefit) and an urban coolingduring hot weather (adaptation benefit). A *conflict* or a trade-off is reported when an adaptation (or mitigation) action leads to negative mitigation (or adaptation) effects. One example of a conflict is given by Tol [42], mentioning that conventional air conditioning aims to reduce the summer heat impact in indoor environments, while it simultaneously increases carbon emissions due to high energy demand.
Against this background, the aim of this paper is to identify interrelationships between adaptation and mitigation (i.e. co-benefits, synergies, trade-offs and conflicts) and evaluate the level of integration of these two typeset al [41]. Out of the overall 885 European CCAPs that were analyzed by Reckien and colleagues [7], the 147 CCAPs that currently combine adaptation and mitigation policies were evaluated. The analysis sheds light on how combined CCAPs in Europe identify and address adaptation-mitigation (Ad/Mit) interrelationships with the potential to significantly contribute to a better understanding of these interrelationships by sectors and by types of measures, with benefits for future integrated climate action policy-making in cities. Tthe above-mentioned notions into local climate action plans is of critical importance. To the best of our knowledge, this is the first comprehensive study of this kind.

3. Methodology

3.1 The sample: Climate Change Action Plans

The selection of the sample is based on a detailed screening process of 885 CCAPs of Urban Audit (UA) database, now called “Statistics on European cities” in the EU-28, as was undertaken by Reckien and others [7]. This study identified that 147 CCAPs from 9 countries combine adaptation and mitigation policy objectives in the same plan. These 147 CCAPs (see Table 1) were reviewed and evaluated. According to the afore-mentioned study [7], the UA defines a city as a local administration unit where the majority of the world population lives: an urban centre of approximately 50,000 inhabitants. However, to ensure representativeness within countries and across the EU-28, the UA also includes some smaller urban areas with less than 50,000 inhabitants. In order to ensure a balanced and regionally representative sample, the UA adopted the following criteria: i) cities in each country should represent about 20% of the population in the country, ii) have a good geographical distribution (at least one city from each Nomenclature of Territorial Units-3 Region), and iii) vary in size to include large and small cities (including some urban centres with less than 50,000 inhabitants).

Reckien and colleagues [7] developed a typology and framework for analysis that classifies 885 CCAPs in the EU-28 based on two dimensions: the alignment with spatial (local, national and international) policies and other climate-related policy documents (see [7] for the detailed classification). In this study, the research sample of 147 CCAPs is classified as type A, comprehensive and stand-alone, as they were developed with a clear focus on climate change for an entire urban area as stand-alone climate policy documents.

Based on their alignment with spatial policies, the research sample can be further classified as Autonomous Plans (i.e. those prepared voluntarily by local government), and Regulatory Plans (i.e. those required by national regulation). Autonomous Plans analysed in this study are from Belgium (1), Germany (4), Finland (4), Ireland (1), Poland (1), Romania (1), and Spain (5). Regulatory Plans analysed in this study - where local action is influenced by national policies - are from France (49) and United Kingdom (81). It should be noted that, while national governments provide policy guidance on the development and design of CCAPs, their contents and legal status is usually left to the discretion of local authorities [7]. The imbalanced composition of the sample with a large number of French and UK integrated CCAPs limits the comparability of the results at the national level.

Table 1. List of analyzed city CCAPs per country (in alphabetical order)

Country	**Number of CCAPs**
Belgium	1
Finland	4
France	49
Germany	4
Ireland	1
Poland	1
Romania	1
Spain	5
UK	81
Total	**147**

All 147 country policy documents included in the analysis were reviewed by researchers who are native speakers.

3.2 Methods and data

Data from the CCAPs was extracted using Content Analysis, a common practice in climate change planning research [5, 7, 34, 37, 2] to assure the impartiality of data analysis as the document analysts are external to city governments.

The Urban Climate Change Integration Index (UCCII) uses variables from this analysis to provide a comparative, comprehensive and standardized evaluation of the integration of Ad/Mit actions. Indicators are developed for each of the three planning stages, “Identifying and Understanding”, “Envisioning and Planning” and “Implementation and Monitoring” [41], as shown in Table 2. Below, the colour coding shows the relation of each variable to mitigation (blue), adaptation (orange), integrated (dark green) andmitigation (grey).

Table 2..

Stage of planning	Sub-stage	Variables	Scoring scale
Identifying and Understanding	Scientific knowledge and information	GHG emissions Profile	0-1
		GHG Emissions Forecast	0-2
		Vulnerability Profile	0-2
		Future Climate Projections	0-2
		Both GHG Emissions and Vulnerability Profile (constructed variable)*	0-1
		Both Emissions Forecast and Climate Projections (constructed variable)*	0-1
		Uncertainty of Climate Impacts	0-1
		Cost Estimates of Damages of Climate Impacts	0-1
		Climate Hazards detailed	0-1
Envisioning and Planning	Targets setting	GHG emissions reductions targets	0-2
		GHG emissions reduction sectoral targets	0-1
		Adaptation Objectives	0-2
		Consideration of both GHG reduction targets and adaptation objectives (constructed variable)*	0-1
	Prioritization	Cost estimates of actions	0-2
		Benefit estimates of actions	0-2
		Consideration of Ad/Mit interrelationships (co-benefits/synergies or trade-offs/conflicts)	0-2
		Sustainability benefits	0-1
	Communication	Common (Ad/Mit) public education and outreach	0-1
	Financing	Common funding body or budget (public)	0-1

Implementation and Monitoring		Financing commitment (public)	0-1
	Implementation	Mainstreaming potential of Climate Actions	0-2
		Common policy or regulatory framework	0-2
		Common coordination/implementation body	0-1
		Partnerships	0-2
	Monitoring	Common Monitoring procedure/ framework	0-2
Highest possible total score			

, that is additional composite variables from combining two variables. Constructed variables are used in the subsequent analysis but the CCAPs score For instance, the constructed variable "Both GHG Emissions and Vulnerability Profile" combines both 'GHG Emissions Profile' and 'Vulnerability Profile' variables.

The majority of indicators responses were coded in binary form – if an indicator was fulfilled the CCAP was given a score of '1', if not it received a score of '0'. Other variables were based on a scoring scale of '0-2' as these indicators did not simply return a yes or no response. Of these variables, two were related to adaptation ("Vulnerability profile" and "Future climate projections"), two were related to mitigation ("GHG emissions forecast" and "GHG emissions reduction targets") and three were related to integration of the two policies ("Consideration of Ad/Mit interrelationships", "Mainstreaming of both Ad/Mit actions" and "Common Monitoring procedure/framework"). Appendix 1 illustrates the scoring mechanism behind these variables.

Particularly with regard to the variable "Consideration of Ad/Mit interrelationships", we investigated whether the CCAPs have explicitly stated co-benefits, synergies, trade-offs or conflicts between mitigation and adaptation within the plans and identified the sectors that the interrelationships occurred.

Two types of analysis were conducted: i) including all the variables of the evaluation framework and ii) including only the 9 integrated variables. The higher a CCAP scores within the overall comprehensive framework, the more integrated the plan is supposed to be. Nonetheless, and as previously mentioned, only 9 of the above variablesa higher score does not necessarily indicate betterIn order to explore whether more comprehensive plans are also better integrated, as described above.
Considering the two types of analyses from a comparative perspective, Spearman's rank correlation coefficient has been applied to explore the level of convergence/ divergence between the score rankings of the two analyses.

To ensure that the CCAPs were reviewed in the same manner, minimising the subjectivity of scoring, detailed guidelines were developed on how to review and evaluate the CCAPs (Appendix

2). The guidelines also included indicator descriptions, score explanations, related keywords and scoring examples. Based on this scoring system, the results for 147 CCAPs are reported.

Analysis of the results is used to groupinto clusters according to their scores (Section 4.2). In the analysis of all variables of the evaluation framework a score of '0-10' is considered an 'early-stage' integrator; a score of '11-20' a 'moderate' integrator; whilst an 'advanced' integrator has a score of '20 or more'.
In the analysis of the 9 integrated variables ascore4'early-' integrator; a score5-8'moderate' integrator; whilst an 'advanced' integrator has a score9-12'. "Early stage integrators" incorporate a few integration elements in their CCAPs aiming to address primarily either mitigation or adaptation. "Moderate integrators" incorporate more integration elements in their CCAPs than the "early stage integrators", while they are adopting a more balanced approach on addressing mitigation and adaptation which is observed in at least two planning stages. "Advanced integrators" incorporate integration elements in all stages of planning in their CCAPs while they are adopting a well balanced approach on addressing mitigation and adaptation.

4. Results

4.1 Evaluation of the level of adaptation and mitigation across different planning stages

Based on the comprehensive review of cities' CCAPs, the sum of the frequencies of each of the variables in the ""colours

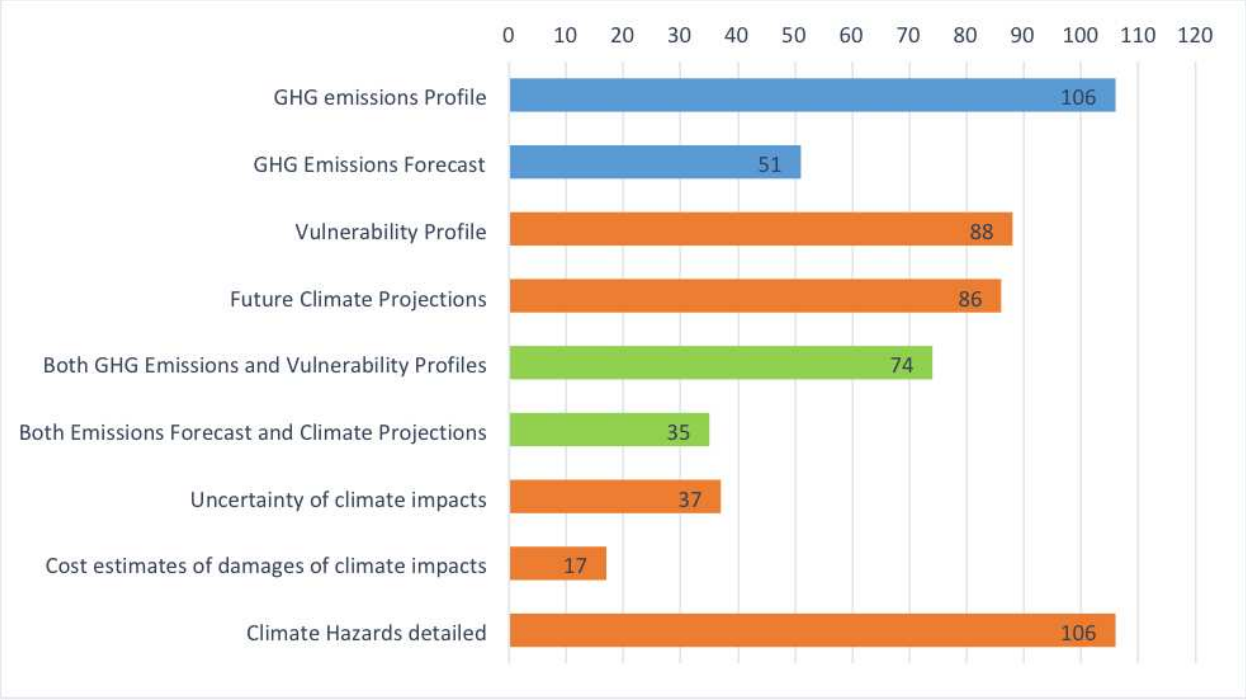


Figure 1. Identification of the level of adaptation and mitigation integration in the 'Identifying and Understanding stage'.

Figure 2 summarises the score components for the “Envisioning and Planning Stage” (lowest frequency)--and relates to one of the integrated variables of adaptation and mitigation.

However, also with regard to integration, n more than half, 84 (57.1%) CCAPs

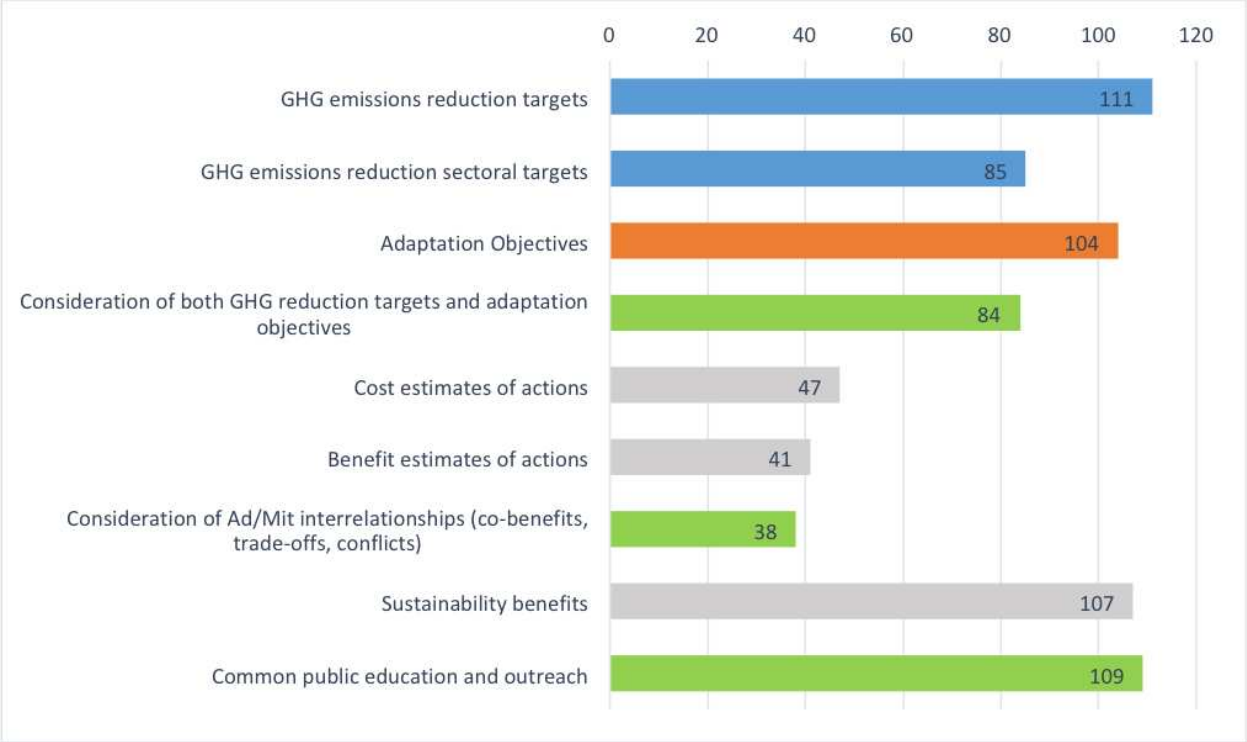
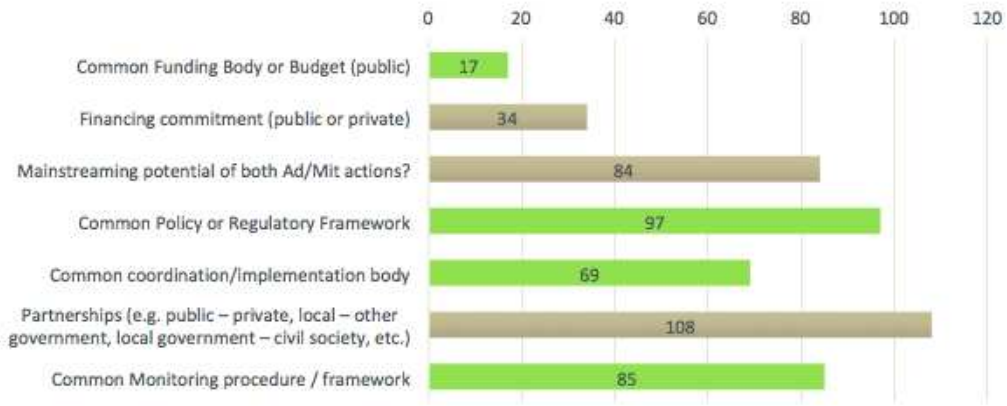


Figure 2. Identification of the level of adaptation and mitigation in the “Envisioning and Planning stage”.

Finally, Figure 3 illustrates the UCCII components of the “Implementation and Monitoring planning stage”. It shows that 108 plans, or 73.5%, use partnerships (public-private, local – other government, local government – civil society, etc.) to support the implementation of actions. In contrast, only 17 CCAPs (11.6%) present a common source of funding body or budget at national or city level to finance a combined approach. The latter also captures the combination of adaptation and mitigation, which reveal a limitation of cities in implementing joint (public) funding bodies or taking budgetary decisions in relation to Ad/Mit. With regard to integration, f



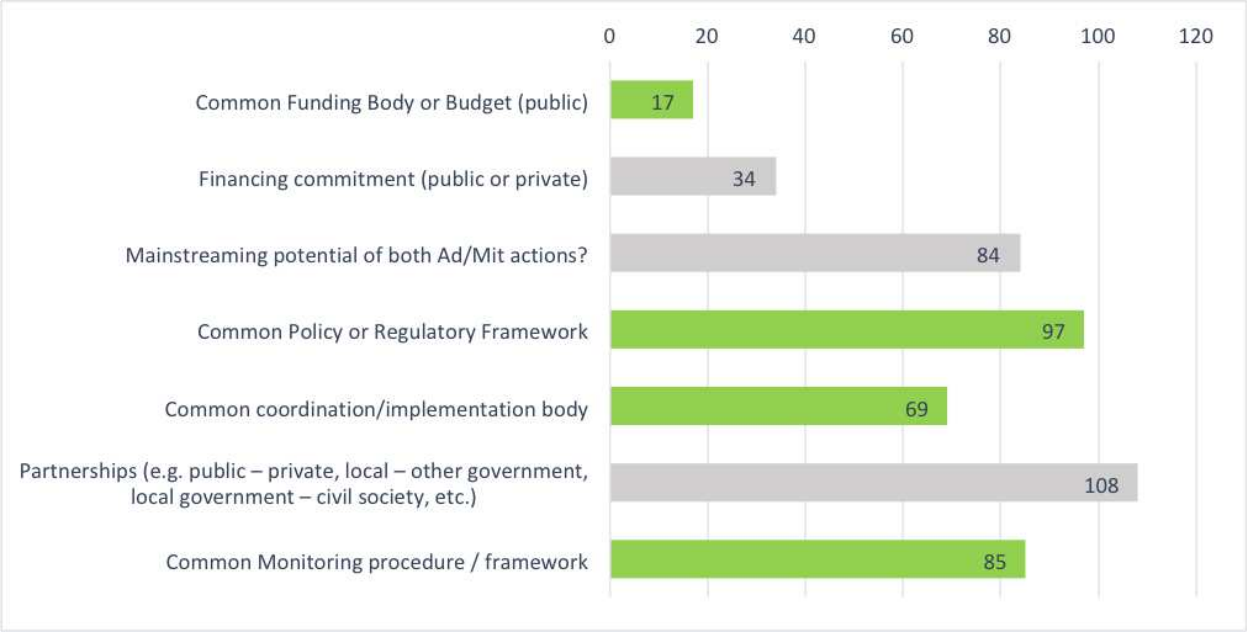


Figure 3. Identification of the level of adaptation and mitigation in the Implementation and Monitoring stage.

4.2 Grouping integrators into clustersdisplays and elaborates on the clusters for cities's CCAPs. In Figures 4a and 4b, tgrouped 'early stage' , '*moderate'* and 'advanced' integrators as described in the methodology section. It should be clarified that thdisplayed in the Lorenz curve in Figure 4a are based on the comprehensive analysis that combines both integrated and non integrated variables, whereas Figure 4b illustrates the scores based the integrated variables.

The results of the grouping in clustersthe comprehensive analysis of CCAPs' scores (Figure 4a) show that 32'early-' integrators (left-side of the vertical black line), 50'moderate' level integrators (between the vertical black and orange lines) and 18'advanced' integrators (right-side of the orange line).

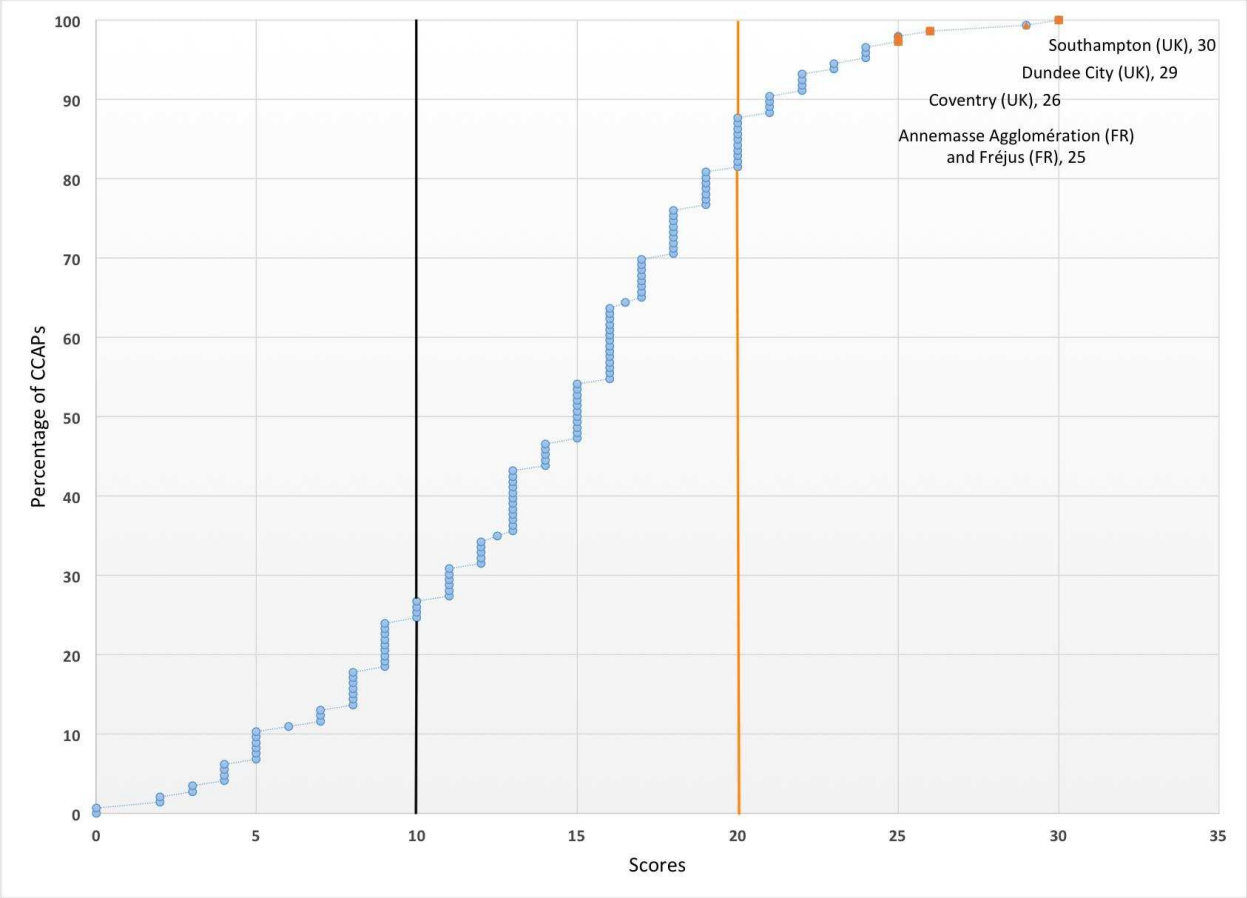


Figure 4a. Percentages of cities' CCAPs scores with threshold of the three integrators clusters.

The five highest integrators of all 147 cities (shown as orange dots) are Annemasse Agglomération (25) and Fréjus (25) in France, Coventry (26), Dundee City (29) and Southampton (30) in the UK. The complete list from the comprehensive review of all cities' CCAPs scores is shown in Appendix 3.

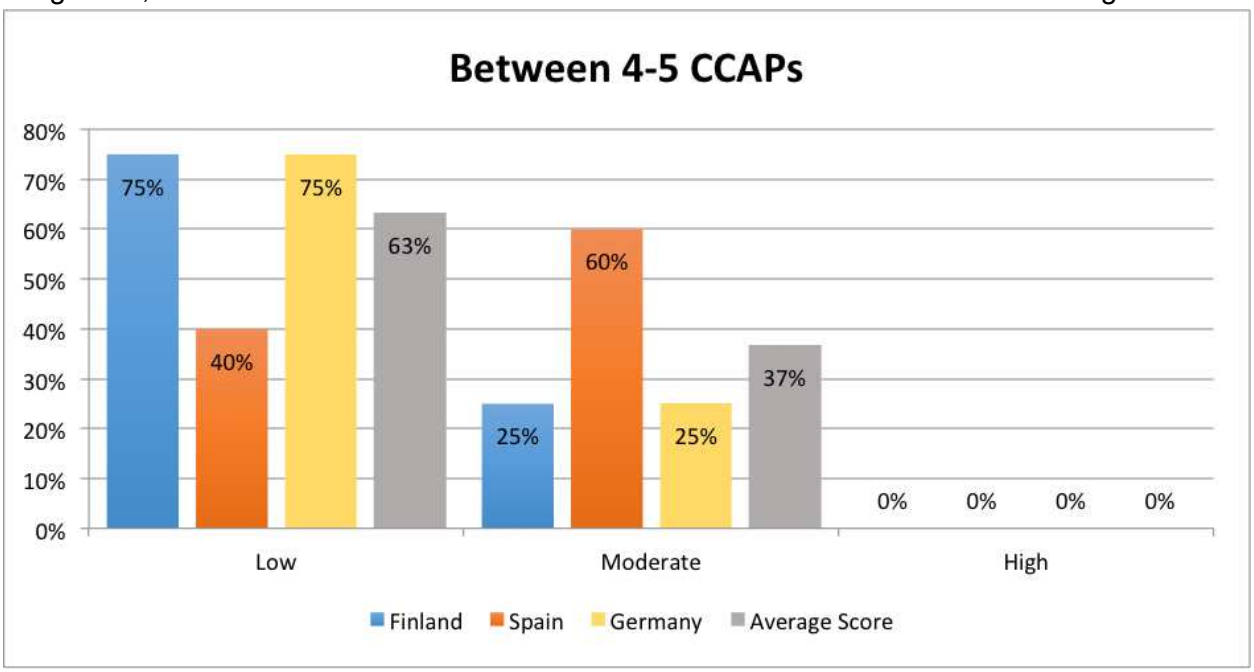
Notably, the results of the grouping into clustersthe integrated variablesanalysis with focus the 9 integrated variables (highlighted in green in Table 2), the highest scoring cities resulted as follows: Cheshire West and Chester (11) in the UK, Annemasse Agglomeration (10) in France, Dundee City (10) as well as Southampton (10) in the UK.

The outcome of the Spearman's correlation coefficient analysis resulted in variables monotonically related, i.e. a high Spearman's correlation coefficient (0.9), suggests that the ranking of CCAPs based on their integrated scores is very similar to the ranking of CCAPs based on the analysis including all variables. One could argue that the previous approach was able to combine both integrated and non integrated variables into a comprehensive framework.

Overall, the analysis based on the 9 integration variables does not provide major changes, even among the top cities. Some differences exist, e.g. Coventry and Frejùs ranked 3rd and 4th,

respectively, and they now both rank 5th. More importantly, Glasgow ranked 18th and now has climbed up to the 5th position. **comprehensive analysis clustersT**analysis(Figure 6). In order to reflect this unbalanced dataset (with the majority of cities' CCAPs being analysed for France and UK), countries are compared only when a limited difference on the number of analysed CCAPs exists. Accordingly, Figure 6 displays .In most countries the majority of cities have a low level of integration ('early-stage' integrators) in 'moderate'On the contrary, 1 CCAP forFinlandy respectively accounts as 'moderate' ior'advanced' integrators. .

In Figure 7 France and the UK are compared according to their France, 51% of its CCAPs are classified as 'early-stage' integrators, 47% as 'moderate' integrators and 2% as 'advanced' integrators. The analysis furthermore shows that 19% of UK cities' CCAPs are 'early-stage' integrators, 78% are 'moderate' and 3% are 'advanced' integrators.



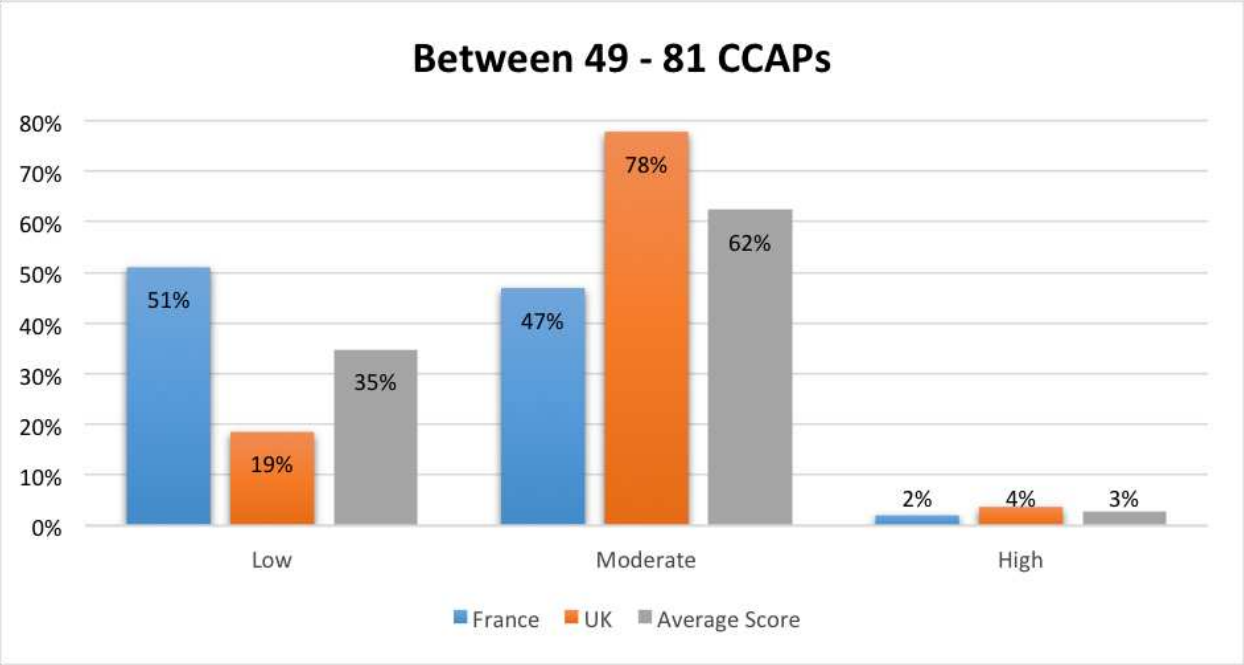


Figure 6. Level of Ad/Mit integration in urban planning at the country level for all 147 cities (percentage).

4.3 Country results and comparisons

This section presents the results of the variables in which the average CCAPs score per country is calculated. Each score was obtained by aggregating the average score of each of the three climate change action planning stages. Similar4.2, Belgium, Ireland, Romania and Poland are not included in the graph as they have only one reviewed CCAP. It was deemed that one CCAP per each country did

Figure 7 (following the rationale of Figure 6 above) is split in two stacked bar charts, the upper one comparing scores for countries with 4 to 5 analysed CCAPs (Finland, Germany, Spain), and the lower one comparing France and UK (countries with CCAPs above 49).
Based on the level of mitigation and adaptation integration in the CCAPs of Finland, Germany and Spain (i.e. the integrated variables) average CCAPs score corresponds to 4.77 Spain 5.20, followed by Germany (4.85) and Finland (4.25) scoring below average.
The average CCAPs score for the UK and France is 4.69, with the UK (5.67) scoring above and France (3.71) scoring below average.

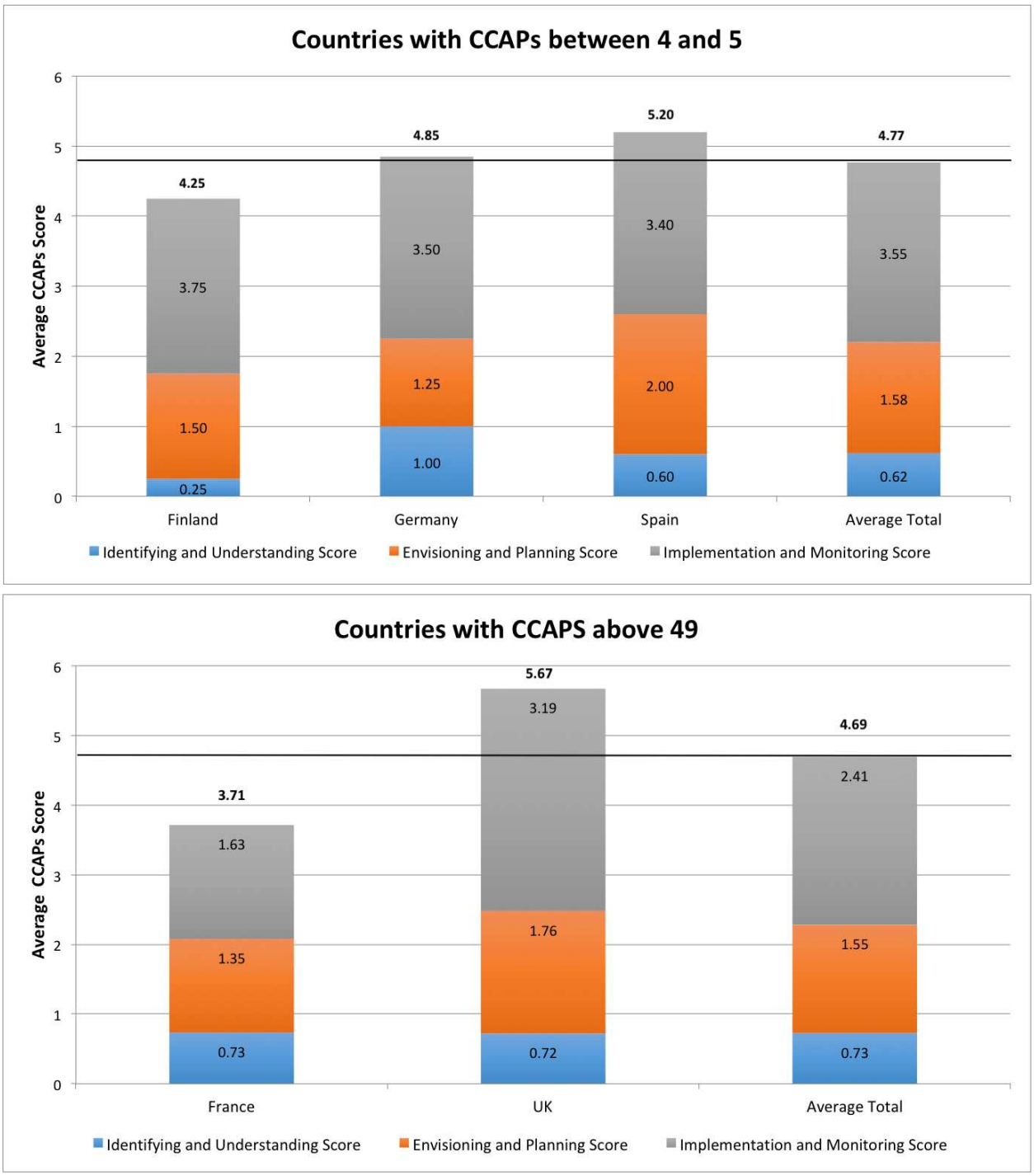


Figure 7. A scores per country. This section offers 52 comprehensive interrelationships, nearly 32% of interrelationships were found in “Green infrastructure”. Other interrelationships were identified in “Construction, energy efficiency and building” (23%) and in “Education and communication” (15%), whilst approximately 10% in “Planning”. The rest of interrelationships are classified under “Flood/water management” (approximately 8%), “Transport” (approximately 8%) and “Consumption” (approximately 4%).

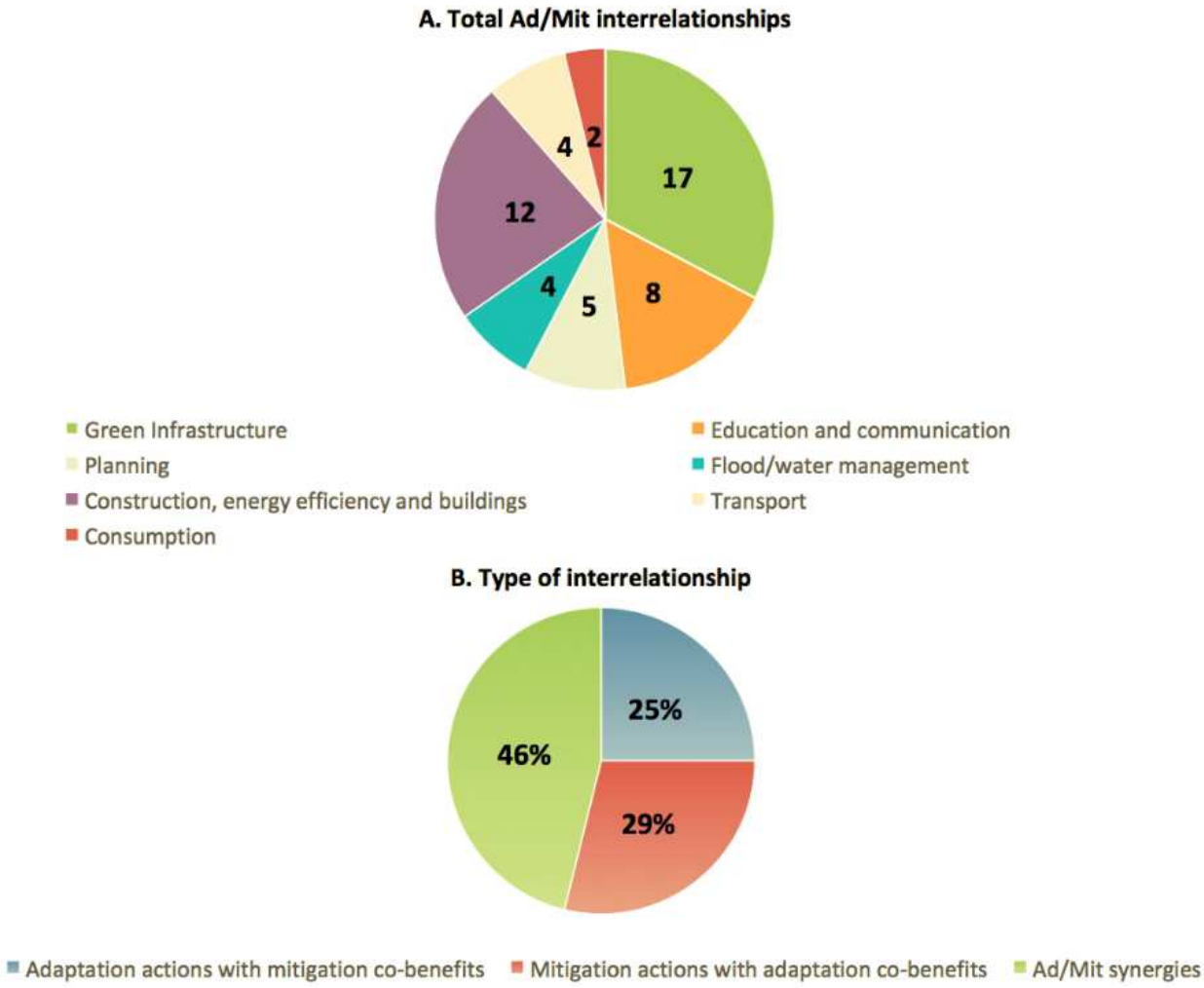


Figure 8. Overall Ad/Mit Interrelationships in different sectors (A) and Overall number of interrelationships based on primary policy objectives (B).

Figure 8 (B) is closely related to the previous one but shows instead the percentage of interrelationships having either adaptation actions with mitigation co-benefits (25%), mitigation actions with adaptation co-benefits (29%) and Ad/Mit synergies (46%)Notably, none of the reviewed CCAPs identified any trade-offs or conflicts of adaptation and mitigation actions.

5. Discussion

5.1 Integration of mitigation and adaptation

About two thirds (71%) of CCAPs include a GHG emissions profile, whereas 60% of them include a vulnerability profile, suggesting that mitigation is still considered more extensively during the initial Identifying and Understanding phase. This can be explained by the fact that European cities initially started addressing climate mitigation in their plans, often as a result of the support from the Covenant of Mayors, but have only more recently started to address adaptation issues, either as stand-alone plans or in combined action plans such as the ones under investigation in this study. This also reflects the initial focus of the global climate policy processes and conventions (i.e. UNFCCC, Kyoto Protocol and Paris Agreement) on climate mitigation. The study shows that about 50% of European cities' combined CCAPs address adaptation and mitigation in a balanced way, including assessments of both GHG emissions and vulnerability profiles. However, when more technical assessments are needed (i.e. GHG emissions forecasts and climate projections), only one quarter of CCAPs have included a more in-depth analysis for both adaptation and mitigation.

Although the cluster of high integrators is the smallest, there is a clear indication that CCAPs are advancing towards increased integration of adaptation and mitigation in France and the UK.
The UK CCAPs scored highly in particular, with 82'moderate' and 'advanced' integrators, against 64 and national CO2 emissions reduction target in UK[2], suggesting that municipalities provided with clear policy guidance from national government are able to better allocate resources that are necessary to undertake CCAPs with stronger integration. The study results are aligned with the outcomes of Reckien et al., 2018, 2019 [7, 49] that showed that cities that are mandated by National governments to develop climate change action plans address both mitigation and adaptation, by far more than those cities that are not mandated by National climate strategies.

When focusing on the level of integration within autonomously generated CCAPs, whilst 63% of German, Finnish and Spanish CCAPs display a low, 37% profile as 'moderate' integrators. One could argue that substantial integrating, networks or from partnerships with other actors such as knowledge-based institutes. In recent years major cities networks, such as the European Covenant of Mayors, ICLEI and C40, haveedIn the future these around theon ofC40 cities have recently developed a qualitative assessment tool for identifying the interactions of adaptation and mitigation actions (AMIA tool[3]).

[2] The Climate Change Act
[3] https://resourcecentre.c40.org/resources/interaction-between-adaptation-and-mitigation-actions

5.2 Interrelationships between mitigation and adaptation

Out of the 147 cities combining both adaptation and mitigation policy objectives in their CCAPs, just over one quarter of them (38) explicitly consider Ad/Mit actions' synergies and co-benefits. Synergies and co-benefits were the type of interrelationships stated most frequently in specific sectors such as "Green Urban Infrastructure", "Construction, Energy efficiency and Buildings" and "Education and Communication", reinforcing the study results by Landauer et alet alanalysis foundcase forrarely include risk assessments or carbon impact assessments. These could be applied across the mitigation/adaptation fields to promote integration actively. A comprehensive review of assessment tools and benchmarking practices for cities can be found in Bose [44] and an application to achieve carbon reduction targets in London is reported by Villarroel and colleagues [45].

Another key observation is that those CCAPs that focused on co-benefits and synergies did not identify conflicts or trade-offs between mitigation and adaptation. In addition to positive synergies and co-benefits, with the breadth of sectors discussed in the CCAPs, some negative interrelationships could be found [13]. Examples of conflicting and synergistic climate actions that could be incorporated into these CCAPs are provided in the study review on interrelating mitigation and adaptation by Landauer and others [14]. However, identifying trade-offs and conflicts requires a special technical capacity and is also time and resource consuming. Necessary support and/or tools such as decision support tools (including carbon impact and climate risk assessments), checklists, softwares, excel based tools and guidelines could be provided to city officials to assist with interrelationships' identification and quantification in different urban sectors or across sectors. Support from national/ regional governments, city networks and research institutes may be critical in this area. Decision support tools for low carbon business planning for cities have come from the EU (The Smart Cities Information System, CommONEnergy, EU urban roadmaps tool), ICLEI (ClearPath™), European Commission (De-risking energy efficiency platform), World Bank (Curb tool), and academic institutions (Can Do Cities from the University of Leeds and CLIMACT Prio tool from Erasmus University Rotterdam). In addition to the benefits of their technical capacity and access to resources, exploring conflicts may be easier for these third parties who can avoid creating the impression of approaching these questions in a politically motivated way.

5.3 Identifying gaps and needs in the different planning stages

The analysis helps to identify capacity gaps and needs of local governments regarding integrated climate change planning. More specifically, with regard to the "Identifying and Understanding" stage, the results suggest that there are knowledge gaps and capacity development needs on technical assessments of future climate impacts and damages and on conducting simultaneously GHG emissions and climate projections. Future climate projections can be used to inform adaptation policies in cities. As Bader and colleagues [46] state, it is important to establish a process where researchers and scientists provide current and future climate data and projections to urban policy makers. On the other hand, it is quite challenging to relate climate projections with cost damage estimates but as reported by Lenk and others [47] decision makers may only require

an order of magnitude on the damage costs that might be avoided by protecting an urban area as this can remove potential barriers in designing and implementing adaptation strategies.

The results of the study suggest that the main gaps and capacity development needs in the "Envisioning and Planning" stage are linked to the identification (and assessment) of Ad/Mit synergies, co-benefits, trade-offs and conflicts, along with the economic assessment of adaptation and mitigation actions during the prioritization process. The costs of implementing actions are often regarded as part of decision support assessments and prioritization processes. However the analysis and results show that in fact this is usually not the case, which could be one of the reasons why often climate change plans are aspirational. In this regard, user-friendly tools and methodologies to support local governments in undertaking economic analysis need to be developed and become available to local governments. These would include i.e, cost-benefit analysis, abatement/adaptation cost analysis, or integrated approaches such as multi-criteria analysis. There are good international examples of cities that have applied such kind of methods to support their climate change action planning like Vancouver, New York, Mexico City and Durban to name a few. However these are very large cities with available resources to undertake such[4]) and mitigation (PROSPECT[5] project funded by the EC) that could be replicated and upscaled addressing also mitigation and adaptation integration and interrelationships issues.

Regarding the "Management and Implementation" stage, the results suggest that establishing a common funding body and securing finance for efficient integration of adaptation and mitigation are major issues that need to be addressed both by local and national governments. On the other hand 84 CCAPs (57%) have identified opportunities for mainstreaming mitigation and adaptation actions in specific sectoral plans and actions maximising the chances of financing from existing allocation of funds and ultimately implementing these actions. Mainstreaming climate change mitigation and adaptation in existing plans could be an efficient way of addressing both policy objectives in a combined manner. However, mainstreaming climate change mitigation and adaptation would require change of the current practices in urban planning, master planning, land use planning and sectoral planning.

5.4 Limitations and future research

Whereas the study found evidence that CCAPs created under upper tier government directives result in higher Ad/Mit integration, mainly because the data is highly UK centric, it should be explored whether there are further correlations between Ad/Mit integration and other city variables. The cities under investigation vary in a number of properties including density, population, GDP/capita etc. and some are active within sustainable transnational networks, which may affect the CCAPs either positively, or negatively. For example, the highest five scoring cities in terms of Ad/Mit integration have a population size ranging from 53,000 to 326,000 inhabitants, which may suggest that small to medium-sized cities recognise that an integrated approach is more cost-efficient considering the limited resources they have comparedanalysis of countries with 4 to 5 CCAPs the majority of plans are 'early-stage' integrators and just over a third display

[4] https://www.covenantofmayors.eu/IMG/pdf/CoM_TwinningsProgramme_infographic_final-HQ.pdf
[5] https://h2020prospect.eu/

a ‘moderate’ level of integration. As for the analysis of countries with 49 to 81 CCAPs, respectively 35% and of UK and France plans ‘early-stage’ and ‘moderate’ integrators, while3% show] Kongsager R, Locatelli B, Chazarin F. Addressing Climate Change Mitigation and Adaptation Together: A Global Assessment of Agriculture and Forestry Projects. Environ Manage 2016;57(2):271–282. doi:10.1007/s00267-015-0605-y.

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Appendix 1: Scoring system

Scoring system related to GHG Emissions Forecast	
Score	**Status**
0	CCAP does not contain a GHG emission forecast.
1	CCAP provides future GHG emissions forecast (up to 2020).
2	CCAP contains a forecast of GHG emissions forecast (beyond 2020).
Scoring system related to Vulnerability Profile	
Score	**Status**
0	CCAP does not mention any vulnerabilities that the city will face.
1	CCAP suggests that a vulnerability profile has been completed but its data is not stated within the plan. **OR** CCAP mentions some vulnerability issues for the city, but does not provide a concise overview.
2	CCAP contains a full vulnerability profile of the city.

Scoring system related to Future Climate Projections	
Score	**Status**
0	CCAP does not mention any future climate projections for the city.
1	CCAP provides future climate projections in the short-term (up to 2020).
2	CCAP provides future climate projections in the long-term (up to 2050).
Scoring system related to GHG emissions reductions target	
Score	**Status**
0	CCAP does not provide a GHG emissions reduction target.
1	CCAP provides reductions target in the short-term (up to 2020).
2	CCAP provides reductions target in the long-term (up to 2050).
Scoring system related to Adaptation Objectives	
Score	**Status**
0	CCAP does not state any adaptation objective.
1	CCAP contains adaptation objectives in the short term (up to 5 years). **OR** CCAP mentions adaptation objectives without specific timescale.
2	CCAP contains adaptation objectives in the long term (more than 5 years).
Scoring system related to Cost estimates of actions	
Score	**Status**
0	CCAP does not include any cost estimate of proposed actions.

1	CCAP provides cost estimates of **either** adaptation or mitigation actions.
2	CCAP provides cost estimates of **both** adaptation or mitigation actions.
Scoring system related to Benefit estimates of actions	
Score	**Status**
0	CCAP does not include any benefit estimate of proposed actions.
1	CCAP provides benefit estimates of **either** adaptation or mitigation actions.
2	CCAP provides benefit estimates of **both** adaptation or mitigation actions.
Scoring system related to Consideration of Ad/Mit interrelationships (co-benefits/synergies or trade-offs/conflicts)	
Score	**Status**
0	CCAP does not include any interrelationship of adaptation and mitigation.
1	CCAP provides **either** synergies or conflicts of adaptation and mitigation.
2	CCAP provides **both** synergies and conflicts of adaptation and mitigation.
Scoring system related to Mainstream potential of climate actions	
0	CCAP does not include any mainstreaming potential of climate actions.
1	CCAP mentions mainstreaming potential of **either** adaptation or mitigation.
2	CCAP mentions mainstreaming potential of **both** adaptation and mitigation.
Scoring system related to Common policy or regulatory framework	
0	CCAP does not include any policy or regulatory framework.

1	CCAP mentions policy or regulatory framework regarding **either** adaptation or mitigation.
2	CCAP mentions policy or regulatory framework addressing both adaptation and mitigation.
Scoring system related to Partnerships	
0	CCAP does not include any partnership possibility.
1	CCAP mentions partnerships regarding **either** adaptation or mitigation.
2	CCAP mentions partnerships regarding **both** adaptation and mitigation.
Scoring system related to Common Monitoring procedure/ framework	
0	CCAP does not include monitoring procedure/framework.
1	CCAP mentions a monitoring procedure/framework regarding **either** adaptation or mitigation.
2	CCAP mentions a monitoring procedure/framework regarding **both** adaptation and mitigation.

Appendix 2: Guidelines for reviewing and analyzing CCAPs

I) Identifying and Understanding stage

Scientific knowledge and information

1) **GHG emissions profile:** Identify whether the CCAP has included GHG profile or inventory that show quantitative summary of most representative data of the city's GHG emissions as well as an adequate sectoral breakdown at both community and government level. Related keywords might be *GHG emissions profile, GHG emissions inventory, GHG emission levels, etc.*
   i) If GHG profile was identified in the plan → Score **1**
   ii) If GHG emissions profile was not included in the plan → Score **0**

➢ Example in Durban's plan, *"The total amount of greenhouse gas emissions recorded for the entire city was 29,360,395 tCO2e. Total emissions are estimated to have increased steadily from 19,937,000 tCO2e in 2002 (a 47% increase over 10 years)"* and *"Durban's GHG Inventory is divided into two sub-inventories, one for the local government emissions, and the other for the emissions from the broader community"* and the sectoral

breakdown of GHG emissions was provided in the form of pie chart → Score 1

2) **GHG Emissions Forecast (with time horizon**): identify whether the CCAP has provided future GHG emissions forecasts in the form of text or chart (graph) that include a consideration of the city's current and projected growth of GHG emission, you will score this variable depending on the time horizon. Related keywords might be *GHG emissions, path, forecast, prospect, projection, etc.*
   i) If GHG emission forecast was estimated **beyond 2020** → Score **2**
   ii) If GHG emission forecast was estimated **up to 2020** → Score **1**
   iii) If GHG emission forecast was not included in the plan → Score **0**

➢ Example from Chicago's plan, "*If Chicago continues on its current path, just like many other cities, its greenhouse gas emissions could increase 35 percent by the year **2050***" with a graph illustrating the city's GHG emission forecast upto 2050 (p.14) → Score 2

3) **Vulnerability Profile**: search whether the plan has provided the city's vulnerability profile that consider climate change impacts by considering vulnerability factors such as exposure, sensitivity, and adaptive capacity into account. In many cases the vulnerability profile has the form of a Vulnerability Assessment, Vulnerability mapping, Climate Risk assessment and mapping. Related keywords are vulnerability profile, *vulnerable areas, hazard map, risk/impact assessment, etc.*
   i) If vulnerability profile/assessment was **supported by quantitative data** → Score **2**
   ii) If vulnerability profile/assessment was **described but without quantitative data** → Score **1**
   iii) If vulnerability profile/assessment was not included in the plan→ Score **0**

➢ Example from Paris's plan, "the Vulnerability and strength of Paris in the face of climate change and the scarcity of resources" was completed separately and is used as a basis for creating the adaptation strategy for Paris. → Descriptive vulnerability assessment without quantitative data → Score 1

➢ Example from Vancouver Plan: "Vulnerability and risk assessment details" were presented in Appendix B → Specific vulnerability assessment in terms of different climate impacts was provided to help identifying vulnerable areas and prioritizing relevant climate actions → Score 2

4) **Future Climate Projections:** identify whether the plan has included climate projections in the form of text/graph that indicate projected changes of the city climate. Related keywords might include *expected changes in climate, temperature, extreme weather events, sea level rise, precipitation, rainfall*, etc. You will score the variable depending on the time horizon of the projection.
   i) If climate projection was set up **beyond 2030** → Score **2**
   ii) If climate projection was set up to **2030 (or no specific time scale)** → Score **1**
   iii) If future climate projection was not included in the plan → Score **0**

➢ Example from Durban's plan, *"The average annual temperature increase is expected to be between 1.5°C and 2.5°C by **2065**, and increase between 3ºC and 5ºC by **2100**." "Potential increase in aggregate rainfall by **2065** with an increase of up to 500 mm by **2100**"* → Score 2

5) **Both GHG emissions and Vulnerability Profiles:** This variable combines variables 1) and 3), illustrating if the city plan includes both GHG emissions and vulnerability profiles
6) **Both Emissions Forecast and Climate Projections:** This variable combines variables 2) and 4), illustrating if the city plan includes both GHG emissions and future climate projections

➢ Variables 5) and 6) are designed to get scores automatically in the final excel spreadsheet, **please continue to the next item directly.**

7) **Uncertainty of climate impacts:** identify whether the plan has suggested **how to address** uncertainties of climate impacts.The estimates of uncertainties are statements intended to describe the limits to knowledge. The IPCC notes that "uncertainties can be classified between **levels of confidence in scientific understanding** (structural uncertainties), and **the likelihoods of specific results** (value uncertainties). Related keywords might include *uncertainties, probabilities, likelihoods, scenarios of* (climate impacts).
   i) If uncertainty of climate impacts was addressed in the plan → Score **1**
   ii) If uncertainty of climate impacts was not included in the plan → Score **0**

8) **Cost estimates of damages of climate impacts:** identify whether the plan has included economic cost estimates of damages (that could be) caused by climate impacts. Related keywords might include *costs, value at risk, economic damages, GDP losses*, etc.
   i) If cost estimates of damages were indicated in the plan→ Score **1**
   ii) If cost estimates of damages were not included in the plan → Score **0**

➢ Example from Vancouver's plan, *"The National Round Table on the Environment and the Economy (NRTEE) found that world-wide greenhouse gas emissions and subsequent climate change impacts could, in turn, have an economic impact on Canada of $5 billion annually by 2020 and between $21 and $43 billion annually by 2050. Specific to BC by the 2050s, timber supply impacts could range from $2 billion to $17 billion annually and flooding damages to coastal dwellings could cost between $1 billion to $8 billion per year." (p.17)* → Score 1

9) **Climate Hazards detailed:** identify whether the CCAP has suggested **specific types** of climate hazards that the city might face as a result of climate change. Related keywords might include: droughts, storms, floods, extreme weather events, heat waves, sea level rise, etc.
   i) If relevant climate hazards were detailed in the plan → Score **1**
   ii) If relevant climate hazards were not detailed in the plan → Score **0**

➢ Example from Durban *"Durban is projected to experience an increase in the frequency and intensity of extreme weather events, including flash floods, droughts, and an increase in the number and severity of coastal storms - which will be exacerbated by sea level rise." (p.5)* → Score 1

II) Envisioning and planning stage

Target setting

1) **GHG emissions reduction targets:** check whether the plan has set out city-level GHG emission reductions targets with time horizon, if so, score the variable based on the

timescale of the targets. Related keywords might include *GHG emission reduction, goals, targets, etc.*

i) If GHG emissions reduction targets were specified and set by **2050** → Score **2**
ii) If GHG emissions reduction targets were specified and set by **2020** → Score **1**
iii) If GHG emissions reduction targets were not included in the plan → Score **0**

➢ Example from Chicago *"Chicago needs to achieve an 80 percent reduction below 1990 GHG emissions level by the year **2050** in order to do its part to avoid the worst global impacts of climate change." (p.14)* → Score 2

2) **GHG emissions reduction sectoral targets :** assess whether the city's total GHG emissions reduction targets were broke down into different sectors that should be responsible for GHG emissions reductions. Related keywords are *sectors (e.g. transportation, buildings, energy, waste, urban green, etc), sectoral emissions, etc.*

i) If sectoral GHG reduction targets were identified → Score **1**
ii) If sectral target for GHG emissions reductions was not included in the plan → Score **0**

➢ Example from Chicago's plan, the city's total GHG reductions were broke down into sectoral targets, for such as "Mitigation actions in Energy Efficient Buildings will contribute to 30% of total Chicago GHG Reductions" → Score **1**

3) **Adaptation Objectives**: identify whether the plan has included a set of adaptation objectives in order to cope with most pressing climate impacts for the city. Climate change adaptation refers to *"The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to **moderate harm or exploit beneficial opportunities**. In natural systems, human intervention may facilitate adjustment to expected climate and its effects."* (IPCC, 2013:3). Related keywords might include *adaptation objectives, strategies, goals, etc.*

i) If adaptation objectives were identified with long term timescale (more than 5 years) → Score **2**
ii) If adaptation objectives were identified with short term timescale (up to 5 years) or without specific time scale → Score **1**
iii) If adaptation objective was not included in the plan → Score **0**

➢ Example from Paris's plan: chapter "*An Adaptation Strategy*", a series of adaptation actions were set out in response to the climate impacts that are increasingly affecting the city, such as "*Heatwaves, urban heat islands effects; Floods, droughts, drinkability, cooling: water and adaptation."* , however, the plan **did not include time scale** for proposed adaptation objectives → score 1

➢ Example from Bangkok's plan: according to the time scale of the main climate impacts in the city (flooding, coastal erosion, drought and saline intrusion), Bangkok will take short term (1-3 years), midterm (3-5 years) and long term (5-10 years) of actions, to prevent, minimize impacts, then change and construct infrastructures. → score 2

4) **Consideration of both GHG reduction targets and adaptation objectives:** determined by whether the plan has included both GHG reduction targets and adaptation objectives.

➢ Variable 4) will be designed to get scores automatically in the final excel spreadsheet, **please continue to the next item directly.**

Prioritization

1) **Cost estimates of actions:** check whether the plan has included cost estimates of implementation of proposed Ad/Mit actions, Related keywords might be *cost, estimates, investment costs, project costs, etc.* You will score the variable based on the contents of the estimation.
   i) If costs were estimated for **both** Ad and Mit actions → Score **2**
   ii) If costs were estimated for **either** Ad or Mit actions → Score **1**
   iii) If cost estimate of actions was not included in the plan → Score **0**

➢ Example from Seoul's plan: cost estimates of project implementation by sector were included in chapter "financial plans and administration" through a summary table.

☐ **Total Project Cost** (2015 - 2020): **Approx. KRW 13.6630 trillion**

(Unit: 1M)

Sector	Total	2015	2016	2017	2018	2019	2020
Total	13,663,064	1,776,779	2,234,503	2,336,021	2,578,585	2,335,823	2,401,353
Energy	2,126,589	294,306	369,921	385,176	372,160	351,195	353,831
Air and Transport	6,162,207	709,492	819,916	973,916	1,279,915	1,168,216	1,210,752
Resource Circulation	1,490,613	157,411	238,673	173,749	199,796	357,720	363,264
Ecology	801,815	115,124	110,429	127,181	141,138	146,873	161,070
Health and Safety	3,081,840	500,446	695,564	675,999	585,576	311,819	312,436

Cost estimates of sectoral projects that can be considered as either Ad or Mit actions → Score 1

2) **Benefit estimates of actions:** check whether the plan has recognized and estimated economic (individual or public) benefits of proposed actions. Related keywords might include *benefits, profits, paybacks, savings, revenues, etc.*
   i) If benefit were estimated for **both** Ad and Mit actions → Score **2**
   ii) If benefits were estimated for **either** Ad or Mit actions → Score **1**
   iii) If benefit estimate of action was not included in the plan → Score **0**

➢ Example from Chicago's plan, *"Huge personal savings come from switching to public transportation-as much as $400 a month when totalling fuel costs, insurance and parking." (p.30)*
"the city has retrofitted 15 million square feet of its office space, saving $6,000,000 on energy costs"(p.17) → benefit estimates were made only for Mit actions → Score **1**

3) **Consideration of Ad/Mit interrelationships:** identify whether the plan has suggested the **interrelationships** of Ad and Mit actions during the Prioritization process. Related keywords: *interrelationships*, *co-benefits, trade-offs, conflicts, cross-cutting, mutual benefits, etc.* In cases that none of these keywords are stated, but there is a clear description of an Ad/Mit synergy, co-benefit or conflict, then the CCAP considers Ad/Mit interrelationships.
For instance if a climate action (e.g. green roofs) is described in a CCAP as an action that will reduce the need for energy for cooling (mitigation) and also the rainwater runoff during intense rainfall (adaptation), then we consider that the CCAP states Ad/Mit interrelationships (in this example synergy), even without using the word synergy or co-benefit.

Interrelationships of Ad and Mit - *conflict, trade-off, co-benefit*
Climate Ad and Mit actions are interrelated- in some cases positively (**synergies**), in others negatively (**conflicts**) – and sometimes decisions on implementation are based on difficult **tradeoffs**. A conflict is a plan, policy, or measure that counteracts or undermines one or more planning goals between adaptation and mitigation. 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. On the contrast, a **trade-off** is a situation that necessitates choosing (balancing) between one or more desirable, but sometimes conflicting, plans, policies, or measures.

i) If **both synergies and conflicts** of Ad/Mit were identified → Score **2**
ii) If **either synergies or conflicts** of Ad/Mit were identified → Score **1**
iii) If interrelationship of Ad and Mit actions was not included in the plan → Score **0**

➢ Example from Vancouver's plan (**co-benefit**) "*Mitigation and adaptation are not mutually exclusive, with many actions contributing to both goals. Examples include water conservation and effective building envelopes which reduce GHGs now, but also mitigate the effects of extended hotter, drier weather in the future." (p.4)* → Score **1**

4) **Sustainability benefits:** Check whether the plan has stated sustainability benefits that were generated (directly or indirectly) by the proposed adaptation or mitigation actions, **apart from the identified co-benefits of Ad and/or Mit** actions. Related keywords: *sustainability co-benefits, quality of life, jobs creation, water quality, human health, etc.*
i) If sustainability benefits were suggested → Score **1**
ii) If sustainability benefit was not included in the plan → Score **0**

➢ Example from Chicago's plan, "Extra benefits: beyond averting changes to our climate, these actions have the potential to offer many other important benefits. Thousands of jobs may be created annually once the actions are underway.

Communication

1) **Common public education and outreach**: identify whether the plan has included actions that aiming at enhancing public knowledge regarding both Ad and Mit. Related keywords might include *education, awareness, knowledge, campaigns, etc.*
i) If public education and outreach for both Ad and Mit actions were identified → Score **1**
ii) If common public education and outreach was not included in the plan → Score **0**

➢ Example from Durban's plan, stated *"Develop a range of audience-appropriate and innovative education and awareness resources to explain climate change, its potential impact on Durban, methods of reducing GHG* emissions and how to adapt to changing conditions." (p.44) → Score **1**

III) Implementation, management and monitoring stage

Financing

1) **Common Funding Body or Budget:** check whether the plan has suggested a common source (national/city level) of funding body or budget to finance **both** Mit and Ad actions. Related keywords might be (usually with "climate" in the name) *financing, funding, budget, etc.*

i) If a common funding body was identified → Score **1**
ii) If common funding body/budget was not included in the plan → Score **0**

- ➢ Example from Wellington's plan: *"Since 2010-2011, the council has allocated funding to specific measures in the Climate Change Action Plan."* → Score **1**
- ➢ Example from Montevideo's CCAP: ***each department*** *should start working on the short-term projects* ***with its budget*** → Score **0**

2) **Financing commitment:** identify whether implementation of some (or all) proposed actions were **financially secured** with clear financing sources, regardless public or private. Related keywords might be *budgeting, funding source, subsidies, grants, financial incentives, etc.*
i) If financing commitments of proposed actions were identified → Score **1**
ii) If financing commitment was not included in the plan → Score **0**

- ➢ Example from Seoul's plan: specific budgeting of proposed climate actions in different sectors (including energy, air and transport, resource circulation, ecology, health and safety) has been included in the Appendix 2. → Score **1**

Implementation

1) **Mainstreaming potential of Ad/Mit actions**: examine whether potentials of mainstreaming climate actions were considered in the plan. In the context of climate change, mainstreaming refers to the incorporation of climate change considerations into established or on-going development programs, policies or management strategies, rather than developing adaptation and mitigation initiatives separately. Related keywords are *mainstreaming, incorporating, integration, etc.*
i) If mainstreaming was suggested for **both** Ad and Mit actions → Score **2**
ii) If mainstreaming was suggested for **either** Ad or Mit actions → Score **1**
iii) If mainstreaming potential was not included in the plan → Score **0**

- ➢ Example from Wellington's plan, *"reducing emissions through an update of the Wellington transport strategy (mitigation)" and "The Climate Change Action Plan now falls within the scope of Our Living City so it can be integrated with other Council projects (adaptation)"* → Mainstreaming was discussed in Both Ad and Mit actions → Score **2**

3) **Common Policy or Regulatory Framework**: identify whether the plan has mentioned a common policy or regulatory framework that provides guidance and requirements of climate change planning and implementation for both Mit and Ad actions. Related keywords might be *policy, regulatory framework, law, etc.*
i) If a common policy/framework regarding **both** Ad and Mit actions was identified → Score **2**
ii) If policies/regulatory frameworks regarding **either** Ad **or** Mit actions were identified → Score **1**
iii) If policy or regulatory framework for climate actions was not included in the plan → Score **0**

- ➢ Example from Wellington's plan, *"The New Zealand Emissions Trading Scheme (NZ ETS), which came into force in 2008, is New Zealand's primary climate change measure.... Wellington City Council and other entities in the city with obligations must comply with the NZ ETS." (Mitigation)* → Score **1**

4) **Common coordination/implementation body**: identify whether there was an established body/department (or an institutional arrangement) responsible for the coordination and/or the implementation of climate actions, including both Mit and Ad. Otherwise it was for various entities (departments) individually to carry out relevant actions without a central coordination. Related keywords are *(often with "climate" in the name) committee, division, department ; coordination, planning, etc.*
   i) If a common coordination/implementation body was identified → Score **1**
   ii) If a common coordination/implementation body was not included in the plan → Score **0**

➢ Example from Bangkok's plan: the city council will establish and strengthen institutional arrangement to design and implement the Master Plan (with a graph to illustrate the institutional arrangement, where the "Steering Committee" provides overall guidance and coordination to ensure consistency and integration of work across different task forces (transport, energy, waste wastewater, urban greening, adaptation) → Score **1**

4) **Partnerships**: identify whether the plan has stated the use of partnerships (public – private, local – other government, local government – civil society, etc.) to support the implementation of both adaptation and mitigation, for example, public-private-partnerships assist realisation of climate actions through the committed financial support provided by private sector. Related keywords are *partnerships, civil society, public-private, etc.*
   i) If the use of partnerships was identified for **both** Ad and Mit actions → Score **2**
   ii) If the use of partnerships was identified for **either** Ad or Mit actions → Score **1**
   ii) If partnership was not included in the plan → Score **0**

➢ Example from Vancouver's plan, "In order to incorporate **adaptation** considerations in City business, there shall be several levels of partnerships formed; (a) Public – private whereby the city shall partner with private entities…(b) Local – other government…" → Score **1**

➢ Example from Bangkok's plan "BMA in partnership with the national government ministries and agencies, takes a major responsibility to **mitigate and adapt to climate change**" → Score **2**

Monitoring

1) **Common Monitoring system**: check whether there was a common monitoring system or committee to review the performance of both Ad/Mit climate actions, allowing revisions and improvements through feedback mechanisms. Related keywords are *monitoring system, evaluation, reporting, review, committee, revisions, adjustments, etc.*
   i) If a common monitoring system was identified for **both** Mit and Ad actions → Score **2**
   ii) If a monitoring system was identified for **either** Mit or Ad actions → Score **1**
   iii) If climate action monitoring system was not included in the plan → Score **0**

➢ Example from Wellington's plan, " the council will monitor the development of climate change **mitigation** measures" → Score 1

➢ Example from Paris' plan, *"Aware of these future changes, back in 2007 the Council of Paris decided that the Climate Action Plan should be updated every five years. As a result, it set up a Climate Action Plan monitoring committee"* → Score 2

Appendix 3: List of all cities' CCAPs scores in descending order and divided per level of integration

City	Country	Identifying and Understanding Score	Envision and Planning Score	Implementation and Monitoring Score	Total Score
Southampton	UK	9	12	9	**30**
Dundee City	UK	9	10	10	**29**
Coventry	UK	9	8	9	**26**
Fréjus	France	9	8	8	**25**
Annemasse Agglo (City Region)	France	7	9	9	**25**
Nice	France	7	10	7	**24**
Béziers	France	8	7	9	**24**
Lincoln	UK	2	0	22	**24**
Martigues	France	7	9	7	**23**
Hastings	UK	6	8	9	**23**
Albi	France	8	8	6	**22**
Marseille	France	5	8	9	**22**
Glasgow	UK	7	7	8	**22**
Luton	UK	9	9	4	**22**
Norwich	UK	5	9	8	**22**
Aix-en-Provence	France	7	7	7	**21**
Cardiff	UK	5	8	8	**21**
Camden	UK	6	6	9	**21**
Cheshire West and Chester	UK	5	8	8	**21**
Crawley	UK	5	8	8	**21**
Valence	France	7	6	7	**20**
Mulhouse	France	6	6	8	**20**
Calais	France	6	7	7	**20**
Leeds	UK	7	8	5	**20**
Portsmouth	UK	6	6	8	**20**
Hackney	UK	7	5	8	**20**
Cambridge	UK	6	8	6	**20**
Brent	UK	7	5	8	**20**
East Staffordshire	UK	6	6	8	**20**
Valencia	Spain	5	8	6	**19**
Hénin-Carvin	France	5	7	7	**19**
York	UK	4	6	9	**19**
Manchester	UK	4	7	8	**19**
Bristol	UK	5	7	7	**19**
Cheltenham	UK	4	6	9	**19**
Bath and North East Somerset	UK	6	7	6	**19**
Kingston-upon-Hull	UK	8	4	7	**19**
Rouen	France	8	4	6	**18**
Cherbourg	France	7	5	6	**18**
Le Mans	France	7	5	6	**18**
Colchester	UK	6	6	6	**18**
Stockton-on-Tees	UK	6	4	8	**18**

City	Country	Identifying and Understanding Score	Envision and Planning Score	Implementation and Monitoring Score	Total Score
Oldham	UK	3	7	8	18
Reading	UK	6	6	6	18
Middlesbrough	UK	5	7	6	18
Torbay	UK	6	6	6	18
Chemnitz	Germany	8	4	5	17
Aubagne	France	8	4	5	17
Lorient Agglomeration (City Region)	France	3	5	9	17
Perpignan	France	6	6	5	17
Warrington	UK	6	4	7	17
Derby	UK	2	6	9	17
Bedford	UK	6	5	6	17
Woking	UK	6	6	5	17
Tunbridge Wells	UK	2	8	7	17
Tampere / Tammerfors score	Finland	0	6	4	16
Turku / Åbo score	Finland	2	3	2	16
Timisoara	Romania	5	6	5	16
Bydgoszcz	Poland	3	7	6	16
Charleville-Mézières	France	6	5	5	16
Communauté d'Agglomération d'Annecy (City Region)	France	6	3	7	16
Basingstoke and Deane	UK	1	5	10	16
Wigan	UK	7	3	6	16
Thurrock	UK	4	7	5	16
Wirral	UK	3	6	7	16
Harrow	UK	3	6	7	16
Tamworth	UK	7	4	5	16
Dublin	Ireland	3	6	6	15
Bruxelles	Belgium	1	4	10	15
Nancy	France	4	9	2	15
Bayonne	France	6	4	5	15
Chambéry	France	5	5	5	15
Salford	UK	4	5	6	15
Waltham Forest	UK	6	4	5	15
Swindon	UK	1	6	8	15
Guildford	UK	7	3	5	15
Dudley	UK	2	7	6	15
Brighton and Hove	UK	4	5	6	15
Kensington and Chelsea	UK	5	2	8	15
Madrid	Spain	6	4	4	14
Nîmes	France	6	5	3	14
Darlington	UK	3	5	6	14
Gloucester	UK	5	4	5	14

City	Country	Identifying and Understanding Score	Envision and Planning Score	Implementation and Monitoring Score	Total Score
Ipswich	UK	3	8	3	**14**
Stevenage	UK	0	0	14	**14**
Helsinki Metropolitan Area score	Finland	3	5	5	**13**
Essen	Germany	2,5	6,5	4	**13**
Montpellier	France	9	4	0	**13**
Douai	France	1	5	7	**13**
Pays de Montbéliard Agglomeration (City Region)	France	0	4	9	**13**
Solihull	UK	4	6	3	**13**
Telford and Wrekin	UK	4	4	5	**13**
Warwick	UK	2	6	5	**13**
Bradford	UK	4	7	2	**13**
Slough	UK	5	1	7	**13**
Hillingdon	UK	5	2	6	**13**
Rotherham	UK	2	3	8	**13**
Duisburg	Germany	5	6	2	**13**
Angers	France	5	7	0	**12**
Walsall	UK	7	2	3	**12**
Ashford	UK	1	6	5	**12**
Eastbourne	UK	3	4	5	**12**
Hyndburn	UK	1	3	8	**12**
Oulu / Uleåborg score	Finland	2	5	4	**11**
Valenciennes	France	5	6	0	**11**
Belfort	France	4	3	4	**11**
Angoulême	France	2	5	4	**11**
Chalon-sur-Saône	France	6	2	3	**11**
Carlisle	UK	2	3	6	**11**
Orléans	France	5	5	0	**10**
Sheffield	UK	3	3	4	**10**
Greenwich	UK	1	8	1	**10**
Falkirk	UK	4	2	4	**10**
Medway	UK	5	0	4	**9**
Bonn	Germany	3	3	3	**9**
Murcia	Spain	2	4	3	**9**
Dijon	France	4	5	0	**9**
Colmar	France	1	4	4	**9**
Arras	France	2	3	4	**9**
Milton Keynes	UK	0	3	6	**9**
Oxford	UK	2	6	1	**9**
Nantes	France	2	6	0	**8**
Reims	France	4	4	0	**8**
Clermont-Ferrand	France	4	4	0	**8**
Brest	France	5	3	0	**8**

City	Country	Identifying and Understanding Score	Envision and Planning Score	Implementation and Monitoring Score	Total Score
Havering	UK	1	3	4	8
North Tyneside	UK	1	3	4	8
Bracknell Forest	UK	3	3	2	8
Plymouth	UK	2	4	2	8
Gateshead	UK	1	4	2	7
Exeter	UK	0	4	3	7
St Albans	UK	1	4	2	7
Elche/Elx	Spain	1	4	1	6
Rozas de Madrid, Las	Spain	0	2	3	5
Poitiers	France	3	2	0	5
Grenoble	France	1	4	0	5
Sandwell	UK	0	2	3	5
Bexley	UK	0	3	2	5
Kirklees	UK	2	2	1	5
Lyon	France	1	3	0	4
Bordeaux	France	1	3	0	4
Saint-Etienne	France	0	3	1	4
Limoges	France	2	2	0	4
Le Havre	France	1	2	0	3
Saint Denis	France	2	1	0	3
Metz	France	0	2	0	2
Belfast	UK	0	1	1	2