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LETTER

Which are the factors influencing the integration of mitigation and adaptation in climate change plans in Latin American cities?

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Abstract

As cities are major contributors to GHG emissions and places where people face multiple climate change impacts, their critical role in responding to climate change is becoming increasingly evident. Cities are developing climate change action plans (CCAPs) focusing their efforts on reducing GHG emissions and adapting to climate change impacts. Despite having the highest urban population in the world, there are a few studies on urban CCAPs in Latin America and the Caribbean (LAC) region. This study assessed the level of integration of mitigation and adaptation (IMA) in urban climate change plans across 44 major LAC cities. The level of IMA was measured by the utilization of the *IMA index*, a comprehensive evaluation framework of indicators. The results showed that more than half of the examined LAC cities have a moderate level of IMA. The study further explored and statistically analyzed 42 institutional, socioeconomic and environmental factors to identify which ones potentially drive or constrain the level of IMA. Five out of 42 factors were found to have a significant impact (p-value < 0.05) on the IMA index. Of the five significant factors, memberships in regional networks *FLACMA* and *UCCI respectively*, and *donor agencies' contribution to the development of urban policies* had a positive impact on IMA index; while *the national climate fund* and *membership in the global network Urban LEDS* had a negative impact. This suggests that cities are most likely to integrate mitigation and adaptation when the development of their CCAPs are supported by donor agencies or collaborating with other cities. The results highlight the important role of donor agencies, international organizations and cities' networks on providing the necessary capacity to cities for addressing climate change in an integrated manner.

1. Introduction

Cities produce more than 70% of global anthropogenic GHG emissions and consume around 75% of total energy demand (IPCC 2014a, UN-Habitat 2016). Latin America and the Caribbean (LAC) is highly urbanized: 81% of the population lives in cities, when the global figure is approximately 55% (UN-DESA 2018). In addition, 60%–70% of LAC regional GDP accrues in urban centers (Bárcena *et al* 2017). As the most unequal region in the world (ECLAC 2016), there might be more needs on intervention for adapting climate change in the region since poor people, particularly living in slums, are exposed and vulnerable to climate impacts (Reyer *et al* 2017). LAC cities have started developing local climate change action plans (CCAPs), often supported by international organizations, to limit their GHG emissions and adapt to increasing climate change and variability.

The IPCC[4] and the World Bank have highlighted the importance of the interrelationships between and integration of climate mitigation and adaptation (IBRD-WB 2010, IPCC 2014b and 2017). Integrating mitigation and adaptation can result in multiple co-

[4] Intergovernmental Panel on Climate Change.

benefits (Harlan and Ruddell 2011, Seto *et al* 2014). However, mitigation and adaptation plans can be counterproductive when disjointed or improperly coordinated (Laukkonen *et al* 2009). Furthermore, studies on the integration of mitigation and adaptation (IMA) have increased with focuses on land and water management and urban planning (Swart and Raes 2007); local climate strategies (Laukkonen *et al* 2009); urbanization typology (Solecki *et al* 2015); and joint institutionalization in city administrations (Göpfert *et al* 2018).

The IMA in CCAPs was explicitly addressed for the first time at the national level by Klein *et al* (2005) in the forestry sector in Bolivia and at the local level by McEvoy *et al* (2006) in urban areas in the UK. Integrating mitigation and adaptation efforts in CCAPs is increasingly recognized as a way to maximize co-benefits and synergies, minimize trade-offs and conflicts and enhance the cost-effectiveness of planning and implementation (Di Gregorio *et al* 2017, Grafakos *et al* 2018).

An evaluation framework for estimating the level of IMA in CCAPs (an IMA index) was only recently developed by Grafakos *et al* (2019). Only a few studies have addressed the factors associated with IMA in climate change policies (Duguma *et al* 2014, Grafakos *et al* 2018).

This study aims to assess the level of IMA in CCAPs in major LAC cities and to explore which institutional, socioeconomic and environmental factors are potential influences. To the best of our knowledge, there is very little related research on CCAPs in the LAC region. Building on an existing body of literature on the analysis and assessment of urban climate policies (Araos *et al* 2016, Aguiar *et al* 2018, Reckien *et al* 2018), this is the first study to address potential factors influencing the level of IMA in local climate action plans in general and in LAC cities in particular.

2. Methods and data

The study statistically tested factors potentially influencing the level of IMA in LAC cities' CCAPs.

We selected 44 cities in LAC as target cities in this study. The 'IMA index' by Grafakos *et al* (2019) was adopted for assessing the IMA level in each city's CCAP. Institutional, socioeconomic and environmental factors possibly influential to the IMA level were identified in the relevant literature, and 42 factors were selected based on the context of the LAC region and data availability. Finally, we conducted Pearson's correlation analysis and multiple regression analysis between IMA index and these factors. Detailed methods are described below.

2.1. Selection of target cities

The criteria for city selection were: (1) a population size of more than one million inhabitants based on data from UN-DESA (2016) and (2) development of climate policies including (a) stand-alone climate plans, (b) sustainable development or environmental plans, or (c) strategic or territorial plans which include action plans on climate change, climate resilience, sustainable energy, or renewable energy. Where a city developed more than one type of plan that contain climate change actions, priority was given in order of (a), (b) and (c). Additionally, sectoral plans were excluded as these did not focus on overall urban climate issues. Metropolitan-level plans were prioritized over city-level plans. Draft plans, plans in the approval process and adopted plans were all included.

Given the above parameters, we initially identified 68 cities with more than one million inhabitants. San Juan in Puerto Rico was excluded from the sample because Puerto Rico is a US territory. Of the 67 remaining cities (see table A1), 44 had developed some type of climate policy or plan (i.e. type a, b, or c). Therefore, 44 cities in 16 countries were selected (see figure 1), accounting for 28% of the total population of the region.

2.2. Data analysis methods

2.2.1. IMA index (dependent variable)

Local climate policy documents were collected from official websites of LAC city governments in July 2018. We conducted a content analysis of these documents to convert qualitative data into quantitative for evaluating the IMA level. This IMA level was represented by the 'IMA index' based on the evaluation framework of Grafakos *et al* (2019). Content analysis of web-based data in combination with statistical analysis has been used extensively in climate policy studies (Araos *et al* 2016, Aguiar *et al* 2018, Klein *et al* 2018, Reckien *et al* 2018). Moreover, utilizing policy documents allows for consistent use of data since all local governments publish and renew climate policy related documents regularly.

The evaluation framework of Grafakos *et al* (2019) consists of 22 qualitative indicators related to the three stages of planning of CCAPs: (1) identifying and understanding, (2) envisioning and planning, and (3) implementation and monitoring. The indicators were scored based on a content analysis of CCAPs in policy documents. The assessment and aggregation of these indicators led to the construction of IMA index (see tables 1 and A3). Cities were classified into three groups according to their total score, IMA index: (i) early-stage integrators (up to 10), (ii) moderate integrators (between 10 and 20), and (iii) advanced integrators (above 20).

2.2.2. Institutional, socioeconomic and environmental factors (independent variables)

Factors potentially influencing the development and implementation of CCAPs were reviewed and assessed

Table 1. Evaluation framework of the level of IMA in CCAPs.

Stage of planning	Component	Indicators (22)
Identifying and understanding	Scientific knowledge and information	GHG emissions profile, GHG emissions forecast, Vulnerability profile, Future climate projections, Uncertainty of climate impacts, Cost estimates of damages of climate impacts, Climate hazards
Envisioning and planning	Target setting	GHG emissions reduction targets, Sectoral GHG emissions reduction targets, Adaptation objectives
	Prioritization	Cost estimates of actions, Benefit estimates of actions, Consideration of Ad/Mit interrelationships, Sustainability benefits
	Communication	Common public education and outreach
Implementation and monitoring	Financing	Common public funding body or budget, Public or private financing commitment
	Implementation	Mainstreaming potential of both M + A, Common policy or regulatory framework, Common coordination/ implementation body, Partnerships
	Monitoring	Common monitoring procedure/framework

Source: adopted from Grafakos *et al* (2019)

Table 2. Institutional, socioeconomic and environmental factors (independent variables) included in this study.

	Institutional (26 variables)	Socioeconomic (7 variables)	Environmental (9 variables)
Integrated CCAPs (Duguma *et al* 2014, Grafakos *et al* 2018)	• National policies: Common climate policy, Common strategy/action plan in the policy, Submission of NAMA/REDD + R-PP and/or NAP (This factor was disaggregated in four: submission of (1) at least one of the three policies, and (2) NAMA (3) REDD + R-PP and (4) NAP, respectively.) • Common national institutional arrangements: common committee/implementing body • Common national climate fund • National joint project/programs	—	—
Stand-alone CCAPs (Corfee-Morlot *et al* 2009, Reckien *et al* 2015, Fuhr *et al* 2018)	• Climate-related governing structure (national and city level tested) • Expert body or commission (city level in this study) • Adoption of national climate strategies (city level) • Member of global city networks: C40, Covenant of Mayors, ICLEI	• City population: size and density· • City GDP per capita • City unemployment rate • City level environmentally-concerned civil society	• Proximity to the coast (renamed 'coastal city' in this study) • Altitude of the city above sea level • Average temp. of warmest; and coldest month in the city • Total amount of rainfall in the city • Number of rainy days in the city
Newly added	• Networks: number of city networks, at least one membership of global networks, at least one membership of regional networks, global (100 resilient cities, Urban LEDS), regional (Mercociudades, FLACMA, AL-LAs, UCCI) • Donor agency contribution to the development of city level CCAPs	• City population growth rate • City level Gini coefficient	• City level CO_2 emissions per capita • Distance from city to equator • Proximity city to the coast (km)

as potentially affecting the level of IMA in CCAPs. These were identified in the literature related to either integrated or stand-alone CCAPs. Integrated CCAPs feature both mitigation and adaptation actions in one plan, while stand-alone CCAPs feature either a mitigation or an adaptation plan (Grafakos *et al* 2018).

Overall, similar to the study of Reckien *et al* (2015), factors identified in the literature can be categorized into three types: institutional, socioeconomic, and environmental. Among them, institutional factors were the most common in the literature (IPCC 2007, Corfee-Morlot *et al* 2009, Bulkeley *et al* 2011, Duguma *et al* 2014, Fuhr *et al* 2018, Grafakos *et al* 2018).

Regarding integrated CCAPs, Duguma *et al* (2014) identified national-level factors such as common policies and strategies, institutional arrangements, financing, and programs and projects. In addition, Grafakos *et al* (2018) addressed city-level factors that can drive or hinder integrated climate actions such as structural conditions, along with available resources and technical means.

With regard to stand-alone CCAPs, Corfee-Morlot *et al* (2009), Reckien *et al* (2015), and Fuhr *et al* (2018) identified factors at the city level. According to Fuhr *et al* (2018), institutional and socioeconomic factors such as the capacity of response to climate-related problems, local democratic practices, and enabling policy frameworks can drive the development of local climate policies. Reckien *et al* (2015) explored drivers of and barriers to the development of stand-alone CCAPs in European cities; however, the IMA was not explored.

Previous studies have suggested a range of factors at different levels of governance. Considering the vertical and horizontal integration that aligns CCAPs with national policies (Corfee-Morlot *et al* 2009, Hardoy and Lankao 2011), we included both national and city level factors. Several additional factors were newly included as shown in table 2. We collected data for all independent variables from official websites of international organizations and national and local governments (see table A2 for data sources).

2.2.3. Correlation and multiple regression analysis

Pearson's correlation coefficient analysis was used to compute the level of significance of independent variables (institutional, socioeconomic, and environmental factors) related to the dependent variable, (IMA index). Based on the results of the correlation analysis, independent variables with 0.05 or higher probability value were considered statistically insignificant. These independent variables therefore are not potentially influential to the dependent variable, IMA index, and were excluded from the next stage: a multiple regression analysis. A multiple regression analysis was conducted to test a model to determine the mathematical expression of the relationship between the independent variables (potentially influential factors) and the dependent variable (IMA index).

We used the software Atlas.ti for qualitative analysis of urban policy documents as part of content analysis to measure IMA index. SPSS and Microsoft Excel were used to conduct correlation and multiple regression analysis in order to explore the relationship between potentially influential factors and IMA index.

Table 3. Ten highest ranking cities based on IMA index.

Rank	City	Country	IMA index
1	Bogota	Colombia	28
2–4	Asuncion	Paraguay	25
	Mendoza	Argentina	
	Mexico City	Mexico	
5–8	Cali	Colombia	24
	Florianopolis	Brazil	
	Montevideo	Uruguay	
	Panama City	Panama	
9	Buenos Aires	Argentina	23
10	Cartagena	Colombia	22

3. Results

3.1. IMA index

Bogota, Colombia's capital, showed the highest level of IMA among the cities under investigation, with a total score of 28, followed by Mendoza in Argentina, Mexico City in Mexico, and Asunción in Paraguay, all with a total score of 25 (see table 3). The average IMA index of the 44 cities was 14.8, indicating a moderate-level of integration. Detailed results showed that out of 44 cities, 23 (52%) are moderate integrators, while 11 (25%) fall into the early-stage integrators category and the remaining 10 cities (23%) to the advanced integrators category (see figure 1).

Out of 44 cities, 13 cities explicitly referred to interrelationships between mitigation and adaptation in their action plans (27 actions in total, see table A4). Of these 13 cities, 6 were included in the top 10 ranked cities based on IMA index (tables 3 and 4). Of the total 27 actions, 13 adaptation actions (48%) with mitigation co-benefits and 5 mitigation actions (19%) with adaptation co-benefits were identified. The remaining 9 (33%) were identified as synergistic actions that could achieve both mitigation and adaptation objectives. None of the cities stated any conflicts or trade-offs between mitigation and adaptation. This result could be explained by the rather negative connotation that conflicts and trade-offs between mitigation and adaptation actions may carry. It was found that positive interrelationships (synergies and co-benefits) could occur in the urban greening sector (33%), followed by biodiversity (22%), water (19%), built environment, energy, agriculture, and land use (see chart 1).

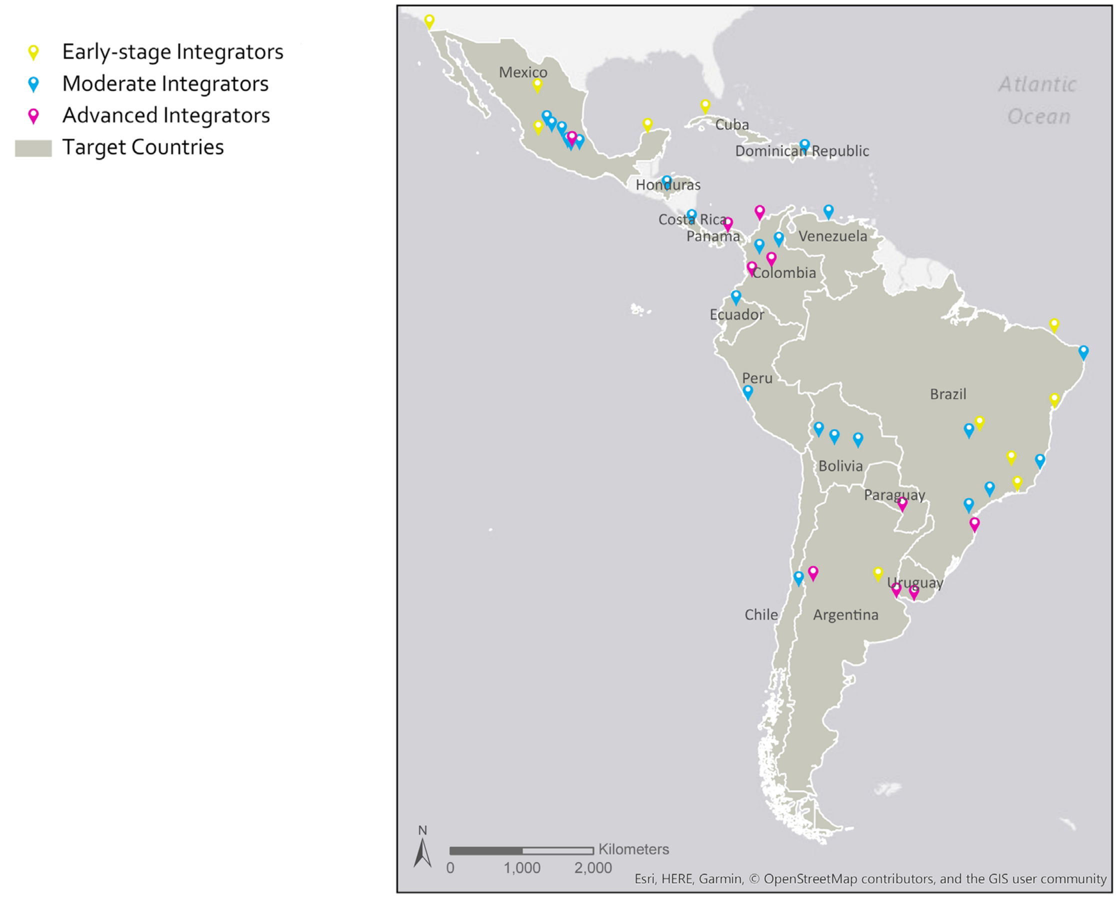

Figure 1. Map of LAC cities clustered according to IMA index.

3.2. Pearson's correlation coefficient analysis

Among the 42 institutional, socioeconomic, and environmental factors, 5 institutional factors were identified as significantly related ($p < 0.05$) to the level of IMA (IMA index), 3 positively and 2 negatively (see table 5). Factors identified as positive (driving factors) include participation in two regional networks: *FLACMA (Federación Latinoamericana de Ciudades, Municipios y Asociaciones Municipalistas*[5]) and *UCCI (Unión de Ciudades Capitales Iberoamericanas*[6]) and *donor agencies' contribution to the development of CCAPs*. On the other hand, factors identified as negative (constraining factors) are: the existence of *national common climate fund* and participation in the global network *Urban LEDS (Low Emissions Development Strategy)*[7]. Out of the three driving factors, the contribution of donor agencies to the development of CCAPs was found as potentially the most influential driving factor showing the strongest correlation, 0.489 ($p < 0.01$). Similarly, between the two constraining factors, national climate fund was identified as potentially the most influential constraining factor (-0.416, $p < 0.01$) (see tables 6 and A5 for the results of the correlation analysis).

[5] The Federation of Latin American Cities, Municipalities and Municipal Associations.

[6] Union of Ibero-American Capital Cities.

[7] Implemented by ICLEI—Local Governments for Sustainability and UN-Habitat.

3.3. Multiple regression analysis with significant factors

Five factors identified from Pearson's correlation coefficient analysis significantly correlated (p-value < 0.05) with the IMA index and were considered predictors when testing for modeling. Those are:

- National common climate fund
- Global network Urban LEDS
- Regional network FLACMA
- Regional network UCCI, and
- Donor agencies' contribution to the development of CCAPs.

The result of multiple regression analysis using the 'enter method' showed that the model explains 47.3% (R square $= 0.473$) of the cases and can be considered as a model of good-fit based on F-value ($6.823 > 1$) and significance p ($0.000125 < 0.001$). One predictor *donor agency contribution to the development of CCAPs*

Table 4. Number of actions with stated positive Ad/Mit interrelationships and sectors that they occur.

City	Country	Number of actions by sector
Cali	Colombia	7 actions: Biodiversity (5), water (1), and built environment (1)
Mexico City	Mexico	4 actions: Urban greening (1), water (2), and agriculture (1)
Cartagena	Colombia	3 actions: Urban greening
Bogota	Colombia	2 actions: Urban greening (1) and water (1)
La Paz	Bolivia	2 actions: Urban greening (1) and energy (1)
Quito	Ecuador	2 actions: Urban greening (1) and built environment (1)
Buenos Aires	Argentina	1 action: Urban greening
Rosario	Argentina	1 action: Built environment
Goiania	Brazil	1 action: Water
São Paulo	Brazil	1 action: Land use
Santiago	Chile	1 action: Energy
Santo Domingo	Dominican Republic	1 action: Urban greening
Montevideo	Uruguay	1 action: Biodiversity

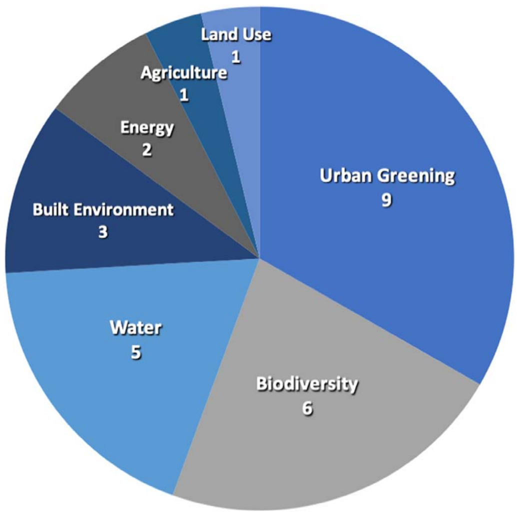

Chart 1. Positive interrelationships stated in action plans by sector.

Table 5. Factors with a significant level of correlation with IMA index.

	Factors with significant level of correlation ($p < 0.05$, $r > +0.30$ or < -0.30)
Positive correlation (Driving factors)	• Institutional factors (3) - Regional network 'FLACMA' - Regional network 'UCCI' - Donor agencies' contribution to the development of CCAPs*
Negative correlation (Constraining factors)	• Institutional factors (2) - National common climate fund* - Global network 'Urban LEDS'

*$p < 0.01$.

was identified as a unique and significant predictor to the model showing a positive relationship (0.467, $p < 0.001$) with IMA index. When the city develops CCAPs with support from donor agencies (assigned value '1'), IMA index (the level of IMA) may increase by 6.203 points (B).

To identify other factors, in addition to donor agency contribution to the development of CCAPs, that may contribute to the model, we applied the 'stepwise method'. This method tests the model by excluding predictors at each step. It is not as commonly used as the 'enter method' due to the risk of the Type II error of missing a significant predictor. However, this risk of Type II error was considered insignificant in this test because the unique significant predictor: donor agency contribution to the development of CCAPs, identified with the enter method, was resulted as one of three factors contributing to the model from the stepwise method. Moreover, this study does not aim to identify the causality (Field 2013).

Multiple regression analysis utilizing the stepwise method showed that the prediction of the model was correct in 45.3% (R square $= 0.453$) of the cases and could be considered as a model of good-fit (F-value $11.029 > 1$ and significance $p < 0.001$). Three predictors were identified as significantly contributing to the model ($p < 0.05$): *donor agency contribution to the development of CCAPs*, membership of regional network *FLACMA* and of global network *Urban LEDS*. Donor agency contribution to the development of CCAPs and membership of FLACMA showed positive relationships with IMA index (0.492, $p < 0.001$ and 0.361, $p < 0.05$, respectively) while the remaining predictor membership of Urban LEDS had a negative relationship. Therefore, the possibility of an increase in IMA index (the level of IMA) rises when receiving donor agencies' assistance in developing CCAPs and being a member of FLAMA, but not of Urban LEDS (phase I).

4. Discussion

Eight out of the 10 highest scored cities (see table 3) developed CCAPs with support from donor agencies; six are capital cities with the largest population in each respective country. Donor agencies may be inclined to

Table 6. Results of correlation analysis (variables of $p < 0.05$).

			IMA index	1	2	3	4	5	6	7	8	9
Institutional factor	1. National climate fund	Pearson Correlation	**−0.416**[a]	.								
		Sig. (2-tailed)	0.005	.								
	2. Global network_Urban LEDS	Pearson Correlation	**−0.299**[b]	**0.346**[b]	.							
		Sig. (2-tailed)	0.048	0.021	.							
	3. Regional network_FLACMA	Pearson Correlation	**0.383**[b]	**−0.363**[b]	−0.126	.						
		Sig. (2-tailed)	0.010	0.016	0.416	.						
	4. Regional network_UCCI	Pearson Correlation	**0.309**[b]	**−0.349**[b]	−0.089	**0.501**[a]	.					
		Sig. (2-tailed)	0.041	0.020	0.568	0.001	.					
	5. Donor agency contribution to the development of plan	Pearson Correlation	**0.489**[a]	−0.224	−0.014	−0.018	0.011	.				
		Sig. (2-tailed)	0.001	0.143	0.926	0.907	0.945	.				
Socioeconomic factor	6. Gini coefficient	Pearson Correlation	−0.142	**0.346**[b]	**0.407**[a]	−0.012	−0.034	0.178	.			
		Sig. (2-tailed)	0.371	0.025	0.007	0.938	0.830	0.261	.	.		
Environmental factor	7. Average temperature of warmest month	Pearson Correlation	−0.260	0.247	0.095	**−0.430**[a]	−0.214	0.049	0.110	.		
		Sig. (2-tailed)	0.089	0.107	0.540	0.004	0.163	0.753	0.488	.		
	8. Average temperature of coldest month	Pearson Correlation	−0.216	0.207	0.140	−0.255	−0.076	0.085	**0.365**[b]	**0.616**[a]	.	
		Sig. (2-tailed)	0.158	0.177	0.364	0.094	0.625	0.548	0.017	0.000	.	
	9. Total amount of rainfall	Pearson Correlation	−0.066	0.190	0.205	0.031	−0.038	0.162	**0.556**[a]	**0.347**[b]	**0.627**[a]	.
		Sig. (2-tailed)	0.673	0.216	0.181	0.841	0.805	0.249	0.000	0.021	0.000	.

[a] Correlation is significant at the 0.01 level (2-tailed).
[b] Correlation is significant at the 0.05 level (2-tailed).

support these cities because of the potentially larger impact based on their relatively high population. Programs implemented by donor agencies are likely to stimulate cities to develop integrated climate plans in line with sustainable development (see table A6). This implies that smaller cities may receive less support for developing their CCAPs and thus be less likely to have IMA in their planning. In addition, all 10 highest scored cities are members of at least one, global or regional city network. Similarly, Reckien *et al* (2015) identified climate networks (i.e. Covenant of Mayors, C40 and ICLEI) as significant drivers of both mitigation and adaptation plans. Networks are involved in climate change experimentation/innovation, which is essential for governing climate change in cities (Broto and Bulkeley 2013). Thus, cities' primary expectation for joining networks might be technical support as well as financial resources from networks (Fünfgeld 2015). This engagement might have eventually influenced cities to integrate mitigation and adaptation in their CCAPs. Regional networks *FLACMA* and *UCCI* were found to be potential driving factors. Both networks were established in the early 1980s with a common purpose: the development of the region. They also have developed strong, steady relationships between member cities and municipalities over a significant period of time. FLACMA, in particular, has recently undergone organizational restructuring in line with SDGs, which may have led to the incorporation of both mitigation and adaptation policy objectives into their policies. In this sense, strong relationships between member cities and the adoption of a common integrated approach to climate change and sustainable development may have positively influenced the level of IMA in their CCAPs.

The global network *Urban LEDS* showed a negative correlation with IMA index. This is because the program aimed to encourage cities to integrate low emissions and green economy strategies into city development plans. The prioritization of mitigation strategies limited the IMA. During the Urban LEDS phase I (2012–2015), four Brazilian cities out of the 44 target cities were included in its cities network: Belo Horizonte, Curitiba, Fortaleza and Rio de Janeiro. These cities showed an average IMA index of 8.5, a relatively low level of IMA. However, in Urban LEDS phase II (2017~), the program has adopted the concept of adaptation co-benefits of low emissions development strategies. Therefore, it may provide more support for IMA in the future.

With regard to the driving factor *donor agencies' contribution to developing CCAPs*, the Inter-American Development Bank (IDB) has been implementing the sustainable urban development program *Ciudades Emergentes y Sostenibles (CES)*[8] in the region since 2011. Program's approach to the development and execution of action plans includes diagnostic analysis and planning policies addressing mitigation and adaptation simultaneously. Nine[9] out of 44 target cities have developed sustainable development action plans including climate actions under the CES program. The average IMA index of those nine cities is 20.78, an advanced integrator score.

In addition to CES, Mexico implemented the program *Plan de Acción Climática Municipal (PACMUN)*[10] with support from ICLEI and funded by DFID[11] to promote a policy framework on mitigation and adaptation actions at the local level. Four Mexican cities in our target cities, Aguascalientes, Cuernavaca, Puebla, and Toluca de Lerdo, have participated in this program.

As mentioned at the beginning of this section, eight out of the top 10 ranked cities according to IMA index have developed local CCAPs with support from international organizations. Thus, the implementation of a city-level program adopting a framework with integrated components of mitigation and adaptation may effectively support Latin American cities in enhancing the level of IMA. The remaining two cities from the top 10, Mexico City and Buenos Aires developed CCAPs without external support. In the introduction section of these plans, they clearly outlined an integrated approach to drawing up action plans in response to climate impact analysis. Mexico City has made continuous efforts to design and implement integrated CCAPs joining multiple city networks[12] that promote an integrated approach to climatic challenges. Buenos Aires, likewise, not only has multiple memberships in city networks[13] but also has financial capacity for climate actions. The city showed the third highest GDP per capita among 67 cities with over one million inhabitants in the region (after Panama City in Panama and San Jose in Costa Rica).

A *national common climate fund* was identified as a significant constraint on the IMA level. Brazil and Mexico established national climate funds in 2009 (regulated in 2010) and 2013 (regulated in 2015) respectively. Even though the Brazilian national climate fund aims at promoting both mitigation and adaptation, it includes more sub-programs on mitigation than adaptation. Under this climate fund, there are two city-focused sub-programs, and these also put more emphasis on mitigation than adaptation (see table A7). Moreover, only 15% of the fund was allocated for adaptation in 2011 (Ludeña and Netto 2011). Thus, the Brazilian climate fund may have influenced the development of mitigation-focused CCAPs. In 2018, the Brazilian ministry of environment

[8] Emerging and Sustainable Cities.

[9] Mendoza-Argentina, Cochabamba-Bolivia, Florianópolis-Brazil, Vitória-Brazil, João Pessoa-Brazil, San José -Costa Rica, Tegucigalpa-Honduras, Panama City-Panama and Asunción-Paraguay.

[10] The Climate Action Plan for Municipalities Programme.

[11] Department for International Development of the United Kingdom.

[12] C40, ICLEI, Global Covenant of Mayors, AL-LAs and UCCI.

[13] 100 Resilient Cities, C40, ICLEI, Global Covenant of Mayors, Mercociudades, FLACMA and UCCI.

established the socio-environmental initiative for reducing urban vulnerability, which is based on the national environment fund and climate fund. Thus, a revision of their national climate fund to create a balance between mitigation and adaptation is necessary to help cities achieve integrated CCAPs. Additionally, although Mexico's national climate fund supports both integrated and stand-alone mitigation and adaptation actions, the fund's establishment came after several cities of our sample developed CCAPs.

Our study, which focuses on CCAPs in the LAC region, contradicts Duguma *et al* (2014), who in examining a global sample of countries, found that a national common climate fund was a significant driver of IMA in climate policies.

Reckien *et al* (2015) found that socioeconomic and environmental factors such as population size and density, GDP per capita, unemployment rate, proximity to coast, and average summer and winter temperatures were potentially influential for the development of CCAPs in Europe. Fuhr *et al* (2018) found that environmentally-concerned civil society and green industries had a significant positive association with the development of CCAPs. In contrast, Duguma *et al* (2014) identified national income-level as insignificant when it came to the potential synergy between mitigation and adaptation. In our study, all of the socioeconomic and environmental factors proved to be insignificant in relation to the level of IMA. First, IMA requires the preexisting of CCAPs. Second, this might be due to the low explanatory power[14] of the tested factors. As the integration of policy objectives is usually more concerned with institutional and policy arrangements, our results also show that institutional factors are significantly associated with the level of IMA.

Although our approach addresses for the first time the factors that potentially relate to the level of IMA, it has also some limitations. Most of the data used were collected through online searches. Policy documents used for drawing indicators of IMA index were mainly from official websites of local governments. Therefore, cities that have not shared CCAPs documents online inevitably were not considered. As documents were collected from May to July 2018, policy documents published or revised after that period were not considered.

There were challenges regarding the collection of data relevant to the selected factors for the target cities. The ECLAC[15] has been working to disseminate environmental statistics[16] in the region (Quiroga 2018). However, the database is still limited to national level and therefore does not provide city-level data. Data for CO_2 emissions per capita were gathered from different sources (see table A2) since none of the existing data sources provided information on CO_2 emissions per capita for all the sample cities. Thus, the year of reported CO_2 emissions per capita and methods used for measuring them may differ depending on the data source.

In addition, challenges of IMA in urban CCAPs faced by policymakers and local stakeholders were also out of the scope of this study. These could be studied by other methods such as surveys, in-depth interviews, and case studies.

Despite the above limitations, utilization of secondary data produced by governments and international organizations may improve the reliability of the data. Moreover, correlation analysis before multiple regression analysis may contribute to reducing multicollinearity by decreasing the number of variables, excluding insignificant indicators.

To our knowledge, only two studies in the literature addressed the influential factors of the IMA: Duguma *et al* (2014), focusing on national level and Grafakos *et al* (2018), with an extensive selection of factors at city level. However, these studies were not region-specific, and the relationship between possible influential factors and the level of IMA was not studied. Reckien *et al* (2015) addressed both driving and constraining factors for the development of stand-alone climate plans of a large number of European cities. In this regard, this study is the first one that addresses potential driving and constraining factors associated with the level of IMA in CCAPs. In addition, it is the first study to assess the level of IMA in CCAPs in the LAC region.

5. Conclusion

Our study, into the potential driving and constraining factors of the level of IMA in CCAPs in LAC cities, found that the significant factors were all institutional factors. Among them, potential driving factors were: (1) membership in regional networks *FLACMA* and (2) *UCCI*; and (3) *contributions of donor agencies to developing CCAPs*. In contrast, factors that potentially constrained the level of IMA were: (1) *national common climate fund*; and (2) membership of global network *Urban LEDS*. The results of multiple regression analysis suggest that the level of IMA may increase when a city receives donor agencies' assistance in developing CCAPs or having a membership in FLAMA and may decrease when having a membership in Urban LEDS (phase I). The contribution of donor agencies to the development of CCAPs was identified as the strongest relationship with IMA index, which means that this factor seems most likely to contribute to the level of IMA in CCAPs in the LAC region.

Further research could investigate the causal relationships between influential factors and IMA level,

[14] *R*-squared of all the tested factors and the regression model were under 0.5, and 'Standard error of the estimate' of the regression model was over 5.

[15] Economic Commission for Latin America and the Caribbean.

[16] The Framework for the Development of Environment Statistics (FDES, 2013).

which correlation and multiple regression analysis do not determine. Additionally, further study on the relation between the existence of a national climate fund and the level of IMA is needed. The current negative relationship could change in the future for several reasons: the Brazilian government has recently established a new initiative for strengthening urban resilience utilizing the national environment fund and climate fund; and Mexico very recently established an integrated climate fund. Last, case studies could be conducted based on in-depth interviews with policy makers and stakeholders of CCAPs with high-level of IMA to gain a better understanding of the challenges and opportunities of integrating mitigation and adaptation in urban CCAPs.

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Appendix

Internet search keywords for policy documents are in three languages, Spanish, Portuguese and French: climate change action plan (in Spanish 'plan de acción para cambio climático'/in Portuguese 'plano de mudança climática'/in French 'le changement climatique'), adaptation (adaptación/adaptação/adaptation), mitigation (mitigación/mitigação/atténuation), energy (energia/energia/énergie), sustainable development plan (plan de desarrollo sostenible or sustentable/plano de desenvolvimento sustentável/plan de développement durable) and strategic plan (plan estratégico/plano estratégico/plan stratégique).

68 cities were identified with more than one million inhabitants based on UN-DESA (2016), and one city, San Juan in Puerto Rico, was excluded from target cities of this study since Puerto Rico is a USA territory. 67 cities are listed in the table below.

Out of 67 cities, 44 cities were identified with climate-related action plans, and these target cities can be classified by type of climate plans: 32 integrated plans, 9 mitigation plans, and 3 adaptation plans.

Table A1. List of target cities and policy documents.

No.	Country	City	Title of policy document	Year of publication	Type of plan
1	Argentina	Buenos Aires	Plan de Acción Frente al Cambio Climático (PACC) 2020 (EN) Action Plan against Climate Change 2020	2015	Integrated
2	Argentina	Córdoba	—	—	—
3	Argentina	Mendoza	Plan de Acción Área Metropolitana de Mendoza Sostenible (EN) Action Plan Sustainable Metropolitan Area Mendoza	2018	Integrated
4	Argentina	Rosario	Plan Ambiental Rosario (EN) Rosario Environmental Plan	2016	Integrated
5	Bolivia	Cochabamba	Plan de Acción Área Metropolitana de Cochabamba Sostenible (EN) Action Plan Sustainable Metropolitan Area Cochabamba	2013	Integrated
6	Bolivia	La Paz	Plan Estratégico Institucional del Gobierno Autónomo Municipal de La Paz (PEI 2016–2020) (EN) Institutional Strategic Plan of the Autonomous Municipal Government of La Paz 2016–2020	2017	Integrated
7	Bolivia	Santa Cruz de la Sierra	Plan Estratégico Institucional (PEI 2016–2020) (EN) Institutional Strategic Plan 2016–2020	2016	Integrated
8	Brazil	Baixada Santista	—	—	—
9	Brazil	Belém	—	—	—
10	Brazil	Belo Horizonte	Plano Plurianual de Ação Governamental (PPAG) 2018–2021 (EN) Multiannual Governmental Action Plan 2018–2021	2017	Mitigation
11	Brazil	Brasília	Plano Plurianual (PPA) 2016–2019 (EN) Multiannual Plan 2016–2019	2016	Mitigation
12	Brazil	Campinas	—	—	—
13	Brazil	Curitiba	Curitiba Ações Estratégicas: Clima e Resiliência (EN) Curitiba Strategic Actions: Climate and Resilience	2016	Integrated
14	Brazil	Florianópolis	Plano de Ação Florianópolis Sustentável (EN) Action Plan Sustainable Florianopolis	2015	Integrated
15	Brazil	Fortaleza	Planos de Ação e Metas Para a Redução de Gases do Efeito Estufa (EN) Action Plan and Greenhouse Gases Reduction Goals	2013	Mitigation
16	Brazil	Goiânia	Goiânia Sustentável: Plano de Ação (EN) Sustainable Goiania: Action Plan	2012	Integrated

Table A1. (Continued.)

No.	Country	City	Title of policy document	Year of publication	Type of plan
17	Brazil	Sao Luís	—	—	—
18	Brazil	Vitória	Plano de Ação Vitória Sustentável (EN) Action Plan Sustainable Vitoria	2015	Integrated
19	Brazil	João Pessoa	Plano de Ação João Pessoa Sustentável (EN) Action Plan Sustainable João Pessoa	2014	Adaptation
20	Brazil	Joinville	—	—	—
21	Brazil	Maceió	—	—	—
22	Brazil	Manaus	—	—	—
23	Brazil	Natal	—	—	—
24	Brazil	Porto Alegre	—	—	—
25	Brazil	Recife	—	—	—
26	Brazil	Rio de Janeiro	Plano de Ação para Redução de Emissões do Município do Rio de Janeiro (EN) Action Plan for Reduction of Emissions of Rio de Janeiro	2013	Mitigation
27	Brazil	Salvador	Planejamento Estratégico 2017–2020 (EN) Strategic Planning 2017–2020	2017	Adaptation
28	Brazil	São Paulo	Diretrizes para o Plano de Ação da Cidade de São Paulo para Mitigação e Adaptação Às Mudanças Climáticas (EN) Guidelines for the Action Plan of São Paulo for Mitigation and Adaptation to Climate Change	2011	Integrated
29	Chile	Santiago	Plan de Adaptación al Cambio Climático para la Región Metropolitana de Santiago de Chile (EN) Climate Change Adaptation Plan for the Metropolitan Region of Santiago de Chile	2012	Integrated
30	Colombia	Bogotá	Plan Distrital de Gestión del Riesgo y Cambio Climático para Bogotá DC 2015–2050 (EN) Risk Management and Climate Change Plan for Bogota D.C. 2015–2050	2015	Integrated
31	Colombia	Bucaramanga	Plan de Desarrollo Gobierno de las Ciudadanas y los Ciudadanos 2016–2019 (EN) Governmental Development Plan for Citizens 2016–2019	2016	Integrated
32	Colombia	Cali	Plan Integral de Mitigación y Adaptación al Cambio Climático para Santiago de Cali (EN) Integral Plan of Mitigation and Adaptation to Climate Change for Santiago de Cali	2017	Integrated
33	Colombia	Cartagena	Plan 4C: Cartagena de Indias Competitiva y Compatible con el Clima (EN) Plan 4C: Cartagena de Indias, Competitive and Compatible with the Climate	2014	Integrated
34	Colombia	Medellín	Plan de Desarrollo 2016–2019, Medellín Cuenta con Vos (EN) Development Plan 2016–2019	2016	Mitigation
35	Costa Rica	San José	San José Capital: de la Acción Local a la Sostenibilidad Metropolitana (EN) Local Action to the Metropolitan Sustainability	2014	Integrated
36	Cuba	Havana	Plan Especial de Desarrollo Integral hasta 2030 (EN) Integral Development Plan by 2030	2016	Mitigation
37	Dominican Republic	Santo Domingo	Plan de Ordenamiento Territorial del Distrito Nacional (POT) Capital 2030 (EN) Territorial Plan of the National District: Capital 2030	2017	Integrated
38	Ecuador	Guayaquil	—	—	—
39	Ecuador	Quito	Plan de Acción Climático de Quito 2015–2025 (EN) Climate Action Plan of Quito 2015–2025	2015	Integrated
40	El Salvador	San Salvador	—	—	—
41	Guatemala	Guatemala City	—	—	—
42	Haiti	Port-au-Prince	—	—	—
43	Honduras	Tegucigalpa	Tegucigalpa y Comayagüela: Capital Sostenible, Segura y Abierta al Público (EN) Tegucigalpa and Comayaguela: Sustainable, Secure and Open to the Public Capital City	2016	Adaptation
44	Mexico	Aguascalientes	Plan de Acción Climática Municipal (PACMUN) (EN) Municipal Climate Action Plan	2013	Integrated

Table A1. (Continued.)

No.	Country	City	Title of policy document	Year of publication	Type of plan
45	Mexico	Mexico City	Programa de Acción Climática de la Ciudad de México 2014–2020 (EN) Climate Action Program for Mexico City 2014–2020	2014	Integrated
46	Mexico	Ciudad Juárez	—	—	—
47	Mexico	Cuernavaca	Plan de Acción Climática Municipal del H. Ayuntamiento de Cuernavaca (EN) Cuernavaca Municipal Climate Action Plan	2014	Integrated
48	Mexico	Guadalajara	Plan Municipal de Desarrollo Visión 2030 Y Plan de Gestión Institucional 2012–2015 para El Municipio de Guadalajara por el Plan Municipal de Desarrollo Guadalajara 500/Visión 2042 (EN) Municipal Development Plan 'Visión' 2030 and Institutional Operation Plan 2012–2015 of the municipality of Guadalajara for the Municipal Development Plan 'Guadalajara 500/Vision 2042'	2016	Mitigation
49	Mexico	León de los Aldama	Programa Municipal de Cambio Climático (EN) Municipal Climate Change Program	2015	Integrated
50	Mexico	Mérida	Programa Municipal de Desarrollo Urbano de Mérida (EN) Urban Development Program of Merida	2017	Mitigation
51	Mexico	Mexicali	—	—	—
52	Mexico	Monterrey	—	—	—
53	Mexico	Puebla	Plan de Acción Climática del Municipio de Puebla (EN) Puebla Climate Action Plan	2013	Integrated
54	Mexico	Querétaro	Propuesta de Plan Municipal de Atención al Cambio Climático 2017–2018 (EN) Proposal of the Municipal Climate Change Plan 2017–2018	2017	Integrated
55	Mexico	San Luis Potosí	—	—	—
56	Mexico	Tijuana	Plan Municipal de Desarrollo 2017–2019 (EN) Municipal Development Plan 2017–2019	2017	Mitigation
57	Mexico	Toluca de Lerdo	Plan de Acción Climático Municipal Toluca (EN) Toluca Municipal Climate Action Plan	2013	Integrated
58	Mexico	Torreón	Plan Estratégico para Torreón con Enfoque Metropolitano 2040 (EN) Torreon Strategic Plan with Focus on Metropolitan Area 2040	2016	Integrated
59	Panama	Panama City	Plan de Acción Panamá Metropolitana Sostenible, Humana y Global (EN) Action Plan of the Sustainable, Humane and Global Panama Metropolitan Area	2015	Integrated
60	Paraguay	Asunción	Plan de Acción Área Metropolitana de Asunción Sostenible (EN) Metropolitan Action Plan of Sustainable Asuncion	2014	Integrated
61	Peru	Lima	Estrategia de Adaptación y Acciones de Mitigación de la Provincia de Lima al Cambio Climático (EN) Mitigation and Adaptation Strategy to Climate Change	2014	Integrated
62	Uruguay	Montevideo	Plan Climático de la Región Metropolitana de Uruguay (EN) Climate Plan of the Metropolitan region in Uruguay	2012	Integrated
63	Venezuela	Barquisimeto	—	—	—
64	Venezuela	Caracas	Avances del Plan Estratégico Caracas Metropolitana 2020 (EN) Progress of the Metropolitan Caracas Strategic Plan 2020	2012	Integrated
65	Venezuela	Maracaibo	—	—	—
66	Venezuela	Maracay	—	—	—
67	Venezuela	Valencia	—	—	—

Table A2. List of data sources.

Variable	Category	Indicator	Source	Remarks
Dependent	Integration index	(22 indicators, see table A3)	City climate change action plans found in local governments' official websites	As of July, 2018 * Indicators are scored based on the content analysis of policy documents. Sum of total values of indicators is to be an integration index.
Independent	Institutional	Both M+A addressed in national climate policies	National climate policies from 16 target countries	
Independent	Institutional	Common climate strategy/action for both M+A included in national policies	National climate policies from 16 target countries	
Independent	Institutional	Submission of NAMA/REDD+ R-PP and/or NAPs	UNFCCC	* Score '1' if the country submitted at least one of three policies
		Submission of NAMA	UNFCCC	
		Submission of REDD+ R-PP	UNFCCC	
		Submission of NAPs (National Adaptation Plans)	UNFCCC	
Independent	Institutional	National committee addressing M+A together	Central governments' official websites or policy documents	
Independent	Institutional	National governance structure: climate related institution, agency, department	Central governments' official websites or policy documents	
Independent	Institutional	National Common climate fund	Central governments' official websites or policy documents	
Independent	Institutional	Previously executed or ongoing joint M+A project/program	ODI-Climate Funds Update	As of 28 February 2018 * Most countries have had joint projects except for Venezuela
Independent	Institutional	Adoption of national climate change strategy	Policy documents of target cities	
Independent	Institutional	City-level governance structure: climate related agency or department	Municipality official website or policy documents	* Existence of climate change or environment or sustainable development department
Independent	Institutional	City-level: establishment of expert body or committee	Municipality official website or policy documents	
		Number of city networks		* Number of membered global and regional city networks
Independent	Institutional	Member of global city network		* Score '1' if a member of at least one global network
		100 resilient cities	Official website of 100 resilient cities	As of June, 2018
		C40	Official website of C40	As of June, 2018
		ICLEI	Official website of ICLEI	As of June, 2018
		Global Covenant of Mayors	Official website of Global Covenant of Mayors	As of June, 2018
		Urban LEDS	Official website of Urban LEDS	As of June, 2018

Table A2. (Continued.)

Variable	Category	Indicator	Source	Remarks
Independent	Institutional	Member of regional city network		* Score '1' if a member of at least one regional network
		Mercociudades	Official website of Mercociudades	As of July, 2018
		FLACMA	Official website of FLACMA	As of July, 2018
		AL-LAs	Official website of AL-Las	As of July, 2018
		UCCI	Official website of UCCI	As of July, 2018
Independent	Institutional	Donor agency contribution to developing plan	Policy documents of target cities	
Independent	Socioeconomic	Environmentally-concerned civil society	Registry list from central or local government official websites	* Brazil: Association of civil society
Independent	Socioeconomic	Population size	UN-DESA: The World's Cities in 2016	2016
Independent	Socioeconomic	Population growth	UN-DESA: The World's Cities in 2016	2000–2016
Independent	Socioeconomic	Population density	Demographia 2018	2016
Independent	Socioeconomic	City-level GDP per capita	Urban World, McKinsey & Company	2015
Independent	Socioeconomic	Gini Coefficient	* UN-HABITAT: World cities report 2016, UN-HABITAT CPI, Atlas Brasil	
Independent	Socioeconomic	Unemployment	Policy documents, Urban Dashboard by IDB, UN-HABITAT CPI	
Independent	Environmental	City-level CO2 emission per capita	CDP, policy documents, Urban Dashboard by IDB, UN-HABITAT CPI	
Independent	Environmental	Proximity to coast	Google map	
Independent	Environmental	Coastal city	Google map	Value '1' if proximity to coast is 10 km or below
Independent	Environmental	Distance to equator	Google map	
Independent	Environmental	Altitude above sea level	Google Earth and information of meteorological station	
*National meteorological office: AR (Rosario), BO	Environmental	Average temperature of warmest month	WMO World Weather Information Service (30 year period, 1981–2010)	
	Environmental	Average temperature of coldest month		
	Environmental	Total amount of rainfall		
	Environmental	Number of rainy days		

Table A3. Evaluation framework for the level of integration of mitigation and adaptation in CCAPs (IMA Index). Reproduced from Grafakos *et al* CC BY 4.0 ©The Author(s) 2019.

Stage of planning	Component	Indicators (22)	Scale	Explanation
Identifying and understanding	Scientific knowledge and information	GHG emissions profile	0–1	Identified (1) or not identified (0) in the plan
		GHG emissions forecast	0–2	Forecast beyond 2020 (2), up to 2020 (1) or not included in the plan (0)
		Vulnerability profile	0–2	Supported by quantitative data (2), identified in the plan but w/o quantitative data (1) or not identified (0)
		Future climate projections	0–2	Projection beyond 2030 (2), up to 2030 (1) or not included in the plan (0)
		Uncertainty of climate impacts	0–1	Addressed (1) or not addressed (0) in the plan
		Cost estimates of damages of climate impacts	0–1	Included (1) or not included (0) in the plan
		Climate hazards (detailed)	0–1	Included (1) or not included (0) in the plan
Envisioning and planning	Target setting	GHG emissions reduction targets (overall)	0–2	Target by 2050 (2), by 2020 (1) or not included in the plan (0)
		GHG emissions reduction targets (by sector)	0–1	Included (1) or not included (0) in the plan
		Adaptation objectives	0–2	Long term (2), short term (1) or not included in the plan (0)
	Prioritization	Cost estimates of actions	0–2	Both M+A (2), either M or A (1) or not included in the plan (0)
		Benefit estimates of actions	0–2	Both M+A (2), either M or A (1) or not included in the plan (0)
		Consideration of M+A interrelationships	0-2	Both synergies and conflicts (2), either synergies or conflicts (1) or not included in the plan (0)
		Sustainability benefits	0–1	Included (1) or not included (0) in the plan
	Communication	Common public education and outreach	0–1	Included (1) or not included (0) in the plan
Implementation and monitoring	Financing	Common public funding body or budget (national/city level)	0–1	Included (1) or not included (0) in the plan
		Public or private financing commitment	0–1	Included (1) or not included (0) in the plan
	Implementation	Mainstreaming potential of both M+A	0–2	Both M+A (2), either M or A (1) or not included in the plan (0)
		Common policy or regulatory framework	0–2	Both M+A (2), either M or A (1) or not included in the plan (0)
		Common coordination/ implementation body	0–1	Included (1) or not included (0) in the plan
		Partnerships	0–2	Both M+A (2), either M or A (1) or not included in the plan (0)
	Monitoring	Common monitoring procedure/framework	0–2	Both M+A (2), either M or A (1) or not included in the plan (0)
Total score (IMA index)				**Maximum 34**

Source: adopted from Grafakos *et al* (2019).

Table A4. Synergies and co-benefits of mitigation and adaptation actions stated in cities' policy documents.

Type	Sector	City (Country)	Action	Description stated in the document
Synergy	Urban Greening	La Paz (Bolivia)	Program for protected areas	• Mitigation - Carbon storage • Adaptation Strengthening resilience by enabling ecosystemic functions, purification of water and soil stabilization
		Cartagena (Colombia)	Habitat and reduction in emission	• Mitigation - Reduction in emissions • Adaptation - Protection against extreme events
			Creation of pocket parks in the influential zone of city center and the rest of the city	• Mitigation - Reduction in emissions • Adaptation - Prevention of landslides and reduction in temperature
			Green roofs and walls in public and private buildings	• Mitigation - Reduction in emissions • Adaptation - Decrease in temperature and • absorption of rainwater
	Biodiversity	Montevideo (Uruguay)	Conservation and restoration of ecosystem	• Mitigation - Reduction in GHG emissions • Adaptation - Adaptation to climate change
	Built environment	Cali (Colombia)	Promotion of the Eco-barrios as mitigation and adaptation strategy	• Mitigation - Reduction in carbon and water footprints • Adaptation - Improvement of ecology systems of the city and mitigation of heat island effect
	Energy	La Paz (Bolivia)	Renewable and eco-efficient energy program	• Mitigation - Reduction in GHG emissions • Adaptation - Strengthening resilience by improving urban living environment
	Land use	São Paulo (Brazil)	Pilot Project: land use in the Aricanduva watershed	• Mitigation - Use of solar energy • Adaptation

Table A4. (Continued.)

Type	Sector	City (Country)	Action	Description stated in the document
				- Capacity to retain rainwater from the increased permeability of the soil and the areas planted with trees as non-structural drainage actions in the Aricanduva watershed
	Water	Goiânia (Brazil)	Protection of water sources program	• Mitigation - Management of water consumption • Adaptation - Mitigation of flooding risks
Co-benefit: Adaptation driven	Urban Greening	Buenos Aires (Argentina)	'Green Buenos Aires' program	• Primary objective: adaptation - Decrease in climate-related damages and in city temperature - Enhancement of surface permeation and collection of rainwater • Co-benefit: Mitigation - Decrease in energy consumption and GHG emissions
		Bogotá (Colombia)	Recovery of the main ecological structure of Bogota	• Primary objective: adaptation - Ecosystem management based on the conservation and maintenance/secure of the vital ecosystem services • Mitigation - Maximizing effect of CO_2 storage: 26 675 tonnes of CO_2 per hectare by conserving green area and 4 tonnes of CO_2 per hectare per year by restoring
		Santo Domingo (Dominican Republic)	Increase in the coverage of urban greening	• Primary objective: adaptation - Decrease in urban temperature • Mitigation - Reduction in emissions
	Biodiversity	Cali (Colombia)	Conservation and restoration of natural areas, associated with the main ecological structure	• Primary objective: adaptation - Reduction in vulnerability of natural systems • Mitigation - Functioning as carbon storage
			Improvement of the management of complementary ecological structure	• Primary objective: adaptation - Improvement of urban green area as a complementary ecological system • Mitigation - Functioning as carbon storage
			Connectivity of the main and complementary ecological structures	• Primary objective: adaptation

Table A4. (Continued.)

Type	Sector	City (Country)	Action	Description stated in the document
				- Conservation by implementing environmental path and urban green path in the process of urbanization • Mitigation - Functioning as carbon storage
			Adaptation and recuperation of green areas and management of urban heat islands	• Primary objective: adaptation - Reduction in heat islands by planting trees and other native species • Mitigation - Functioning as carbon storage
			Improvement and conservation of the vegetation in tropical dry forest	• Primary objective: adaptation - Development of innovative strategies for localized individual gardens and green areas to reduce heat islands • Mitigation - Functioning as carbon storage
	Water	Bogotá (Colombia)	Recuperation of the Bogota river basin program	• Primary objective: adaptation - Improvement of water treatment and supply, and sanitation • Mitigation - Reduction in emissions by adopting the concepts of clean production and eco-efficient buildings
		Cali (Colombia)	Protection of the aquifer recharge zone	• Primary objective: adaptation - Strategy for water supply against CC • Mitigation - Functioning as carbon storage
		Mexico City (Mexico)	Water saving in public buildings and collecting rainwater	• Primary objective: adaptation - Reduction in water usage to secure water supply • Mitigation - indirect reduction in CO_2 emissions by using less energy when processing water
			Suppression of water leakage and rehabilitation of water pipes	• Primary objective: adaptation - Reduction in water leakage • Mitigation - Indirect contribution to reducing CO_2 emissions by using less energy in the pumping stations
	Agriculture	Mexico City (Mexico)	Production control for the standards of food harmlessness	• Primary objective: adaptation - Improvement of local food production

Table A4. (Continued.)

Type	Sector	City (Country)	Action	Description stated in the document
Co-benefit: mitigation driven	Urban greening	Mexico City (Mexico)	Management of urban hills	• Mitigation - Indirect reduction in CO_2 emissions by decreasing inter-region food trade • Primary objective: mitigation - CO_2 capture
	Built environment	Quito (Ecuador)	Sustainable construction	• Adaptation - Mitigation of heatwave and contribution to regulating local climate • Primary objective: mitigation - Reduction in emissions • Adaptation
	Built environment (and Energy)	Rosario (Argentina)	Sustainable construction and energy efficiency	- Maintenance of temperature - Collecting rainwater • Primary objective: mitigation - Enhancement of energy efficiency by establishing the energy performance certificate for construction
	Carbon footprint	Quito (Ecuador)	Carbon footprint and compensation	• Adaptation - Reduction in climate impacts on buildings by enhancing soil absorption • Primary objective: mitigation - Reduction in emissions • Adaptation
	Energy	Santiago de Chile (Chile)	Diversification of energy sources for energy supply	- Prevention of the forest degradation • Primary objective: mitigation - Reduction in GHG emissions • Adaptation - Improvement of energy system flexibility for the adaptation to hydrology, temperature, wind and other climatic factors

Letters

Table A5. Results of correlation analysis.

		Integration index	Integrated plan	Mitigation plan	Adaptation plan	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Integration index	Pearson Correlation
	Sig. (2-tailed)
	N
Integrated plan	Pearson Correlation	.572**
	Sig. (2-tailed)	0.000
	N	44
Mitigation plan	Pearson Correlation	-.603**	-.828**
	Sig. (2-tailed)	0.000	0.000
	N	44	44
Adaptation plan	Pearson Correlation	-0.045	-.442**	-0.137
	Sig. (2-tailed)	0.771	0.003	0.375
	N	44	44	44
1. National_common climate policy	Pearson Correlation	0.053	-0.058	0.004	0.097
	Sig. (2-tailed)	0.735	0.706	0.979	0.532
	N	44	44	44	44
2. National_common climate strategy/action plan in policy	Pearson Correlation	-0.249	-0.225	0.127	0.195	.498**
	Sig. (2-tailed)	0.103	0.142	0.411	0.206	0.001
	N	44	44	44	44	44
3. National_submission of NAMA/REDD+ R-PP and/or NAPs	Pearson Correlation	-0.081	-0.266	0.221	0.118	.627**	.605**
	Sig. (2-tailed)	0.603	0.081	0.150	0.447	0.000	0.000
	N	44	44	44	44	44	44
4. National_submission of NAMA (Nationally Appropriate Mitigation Actions)	Pearson Correlation	0.002	0.028	0.033	-0.103	0.231	0.081	.455**
	Sig. (2-tailed)	0.992	0.858	0.830	0.508	0.131	0.602	0.002
	N	44	44	44	44	44	44	44
5. National_submission of REDD+ R-PP (Readiness Preparation Proposal)	Pearson Correlation	-0.068	-0.210	0.141	0.147	.660**	.525**	.802**	0.242
	Sig. (2-tailed)	0.662	0.171	0.363	0.342	0.000	0.000	0.000	0.114
	N	44	44	44	44	44	44	44	44
6. National_submission of NAPs (National Adaptation Plans)	Pearson Correlation	-0.050	-0.248	0.176	0.156	0.284	0.078	.345*	-0.270	.430**
	Sig. (2-tailed)	0.746	0.105	0.253	0.313	0.062	0.613	0.022	0.077	0.004
	N	44	44	44	44	44	44	44	44	44
7. National_common committee	Pearson Correlation	-0.142	-0.194	0.160	0.086	-0.113	0.273	.511**	0.173	.583**	0.251
	Sig. (2-tailed)	0.358	0.208	0.298	0.581	0.464	0.073	0.000	0.262	0.000	0.100
	N	44	44	44	44	44	44	44	44	44	44
8. National_governance structure: climate related institution, agency, department, unit	Pearson Correlation	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b	.b
	Sig. (2-tailed)
	N	44	44	44	44	44	44	44	44	44	44	44
9. National_common climate fund	Pearson Correlation	-.416**	-.466**	.329*	0.296	.327*	.657**	.397**	-0.133	.495**	.307*	0.289	.b
	Sig. (2-tailed)	0.005	0.001	0.029	0.051	0.030	0.000	0.008	0.390	0.001	0.043	0.057	
	N	44	44	44	44	44	44	44	44	44	44	44	44
10. National_previously executed or ongoing joint project/program	Pearson Correlation	0.110	-0.093	0.077	0.041	.426**	0.212	.351*	0.160	0.281	0.121	-0.048	.b	0.139
	Sig. (2-tailed)	0.478	0.547	0.618	0.790	0.004	0.167	0.020	0.301	0.064	0.434	0.756		0.367
	N	44	44	44	44	44	44	44	44	44	44	44	44	44
11. City_adoption of national climate change strategy/action plan	Pearson Correlation	0.266	0.176	-0.146	-0.078	.342*	0.207	.416**	.549**	.301*	0.083	0.144	.b	-0.141	0.146
	Sig. (2-tailed)	0.081	0.252	0.344	0.615	0.023	0.177	0.005	0.000	0.047	0.593	0.351		0.360	0.345
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44
12. City_governance structure: climate related agency or department	Pearson Correlation	0.127	0.037	-0.086	0.073	0.187	0.186	-0.118	-0.258	0.068	0.029	-0.086	.b	0.247	-0.041	0.078
	Sig. (2-tailed)	0.412	0.812	0.577	0.637	0.224	0.227	0.447	0.090	0.659	0.849	0.581		0.106	0.790	0.615
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
13. City_establishment of expert body or committee	Pearson Correlation	0.147	0.094	0.036	-0.225	-0.139	0.013	-0.017	-0.130	-0.100	.384*	0.102	.b	-0.017	0.127	0.223	0.042
	Sig. (2-tailed)	0.341	0.542	0.814	0.142	0.368	0.932	0.912	0.399	0.517	0.010	0.509		0.913	0.412	0.146	0.788
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
14. Number of city networks	Pearson Correlation	0.159	-0.080	0.106	-0.029	-0.098	-0.059	-0.071	-0.287	-0.019	0.181	0.034	.b	-0.121	0.017	0.048	-0.057	.439**
	Sig. (2-tailed)	0.303	0.608	0.493	0.850	0.528	0.703	0.645	0.059	0.904	0.240	0.825		0.435	0.915	0.756	0.715	0.003
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
15. Network_global (at least one)	Pearson Correlation	0.257	0.013	-0.088	0.118	0.040	0.212	0.151	-0.167	0.209	0.218	0.295	.b	0.023	-0.066	0.167	0.129	.362*	.551**
	Sig. (2-tailed)	0.092	0.935	0.572	0.447	0.796	0.168	0.329	0.279	0.173	0.156	0.052		0.884	0.669	0.279	0.404	0.016	0.000
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
16. Network-global_100 resilient cities	Pearson Correlation	0.204	-0.069	0.022	0.086	0.004	0.008	0.067	-0.079	0.006	0.176	-0.036	.b	-0.237	0.077	0.192	-0.086	0.151	.590**	0.221
	Sig. (2-tailed)	0.183	0.656	0.886	0.577	0.979	0.958	0.668	0.608	0.969	0.253	0.818		0.122	0.618	0.211	0.577	0.328	0.000	0.150
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
17. Network-global_C40	Pearson Correlation	0.044	-0.083	0.069	0.037	0.058	0.117	0.127	-0.028	0.210	0.248	0.194	.b	0.056	0.093	0.130	-0.037	.321*	.688**	0.266	.449**
	Sig. (2-tailed)	0.776	0.591	0.656	0.812	0.706	0.448	0.412	0.858	0.171	0.105	0.208		0.719	0.547	0.400	0.812	0.034	0.000	0.081	0.002
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
18. Network-global_ICLEI	Pearson Correlation	-0.159	-0.232	0.079	0.283	0.055	0.207	0.042	-0.180	0.192	0.176	0.144	.b	0.224	0.146	-0.002	0.258	0.130	.417**	.416**	0.079	.334*
	Sig. (2-tailed)	0.301	0.129	0.608	0.063	0.721	0.177	0.785	0.242	0.211	0.252	0.351		0.143	0.345	0.989	0.090	0.399	0.005	0.005	0.608	0.027
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
19. Network-global_Global Covenant of Mayors	Pearson Correlation	0.241	0.000	0.033	-0.052	-0.041	0.028	0.036	-0.131	0.063	0.135	0.183	.b	0.000	-0.088	0.131	0.052	.374*	.663**	.753**	0.293	.354*	0.131
	Sig. (2-tailed)	0.114	1.000	0.834	0.737	0.790	0.858	0.817	0.395	0.686	0.383	0.236		1.000	0.570	0.395	0.737	0.012	0.000	0.000	0.054	0.019	0.395
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
20. Network-global_Urban LEDS	Pearson Correlation	-.299*	-.339*	.428**	-0.086	0.113	0.227	0.138	-.331*	0.171	.399**	0.100	.b	.346*	0.048	0.014	0.086	.380*	.343*	0.138	0.036	0.161	.331*	0.183
	Sig. (2-tailed)	0.048	0.024	0.004	0.581	0.464	0.138	0.373	0.028	0.266	0.007	0.518		0.021	0.756	0.926	0.581	0.011	0.023	0.373	0.818	0.295	0.028	0.236
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
21. Network_regional (at least one)	Pearson Correlation	0.175	0.020	-0.016	-0.009	-0.245	-0.182	-0.297	-.555**	-.370*	0.141	-0.216	.b	-0.160	-0.104	-0.226	-0.185	.370*	.609**	0.236	0.225	.309*	0.067	.394**	0.216
	Sig. (2-tailed)	0.255	0.898	0.915	0.955	0.110	0.236	0.050	0.000	0.013	0.361	0.159		0.298	0.501	0.139	0.230	0.013	0.000	0.122	0.141	0.041	0.667	0.008	0.159
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
22. Network_regional_Mercociudades (Sud America)	Pearson Correlation	-0.055	0.000	0.056	-0.090	-0.215	-0.144	-.435**	-.683**	-.325*	.327*	-.316*	.b	0.000	-0.152	-.319*	0.090	.370*	.477**	0.186	0.169	0.204	0.046	0.262	.316*	.683**
	Sig. (2-tailed)	0.724	1.000	0.716	0.561	0.161	0.352	0.003	0.000	0.031	0.030	0.037		1.000	0.323	0.035	0.561	0.013	0.001	0.226	0.273	0.184	0.769	0.085	0.037	0.000
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
23. Network_regional_FLACMA (Federación Latinoamericana de Ciudades, Municipios y Asociaciones	Pearson Correlation	.383*	0.243	-0.201	-0.107	-0.066	-.413**	-0.189	-0.151	-0.101	-0.179	-0.105	.b	-.363*	0.061	-0.247	-0.155	-0.061	.462**	0.173	0.127	0.203	0.151	0.229	-0.126	0.271	0.000
	Sig. (2-tailed)	0.010	0.111	0.190	0.487	0.668	0.005	0.218	0.329	0.516	0.244	0.499		0.016	0.696	0.106	0.314	0.693	0.002	0.262	0.412	0.187	0.329	0.134	0.416	0.075	1.000
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
24. Network_regional_AL-LAs (Alianza Euro-Latinoamericana de cooperación entre ciudades)	Pearson Correlation	0.024	-0.152	0.242	-0.118	0.156	0.182	0.189	0.042	0.088	0.038	-0.079	.b	-0.023	0.066	0.206	0.118	0.270	.575**	0.189	.396**	.431**	0.206	0.251	0.295	0.297	0.186	0.008
	Sig. (2-tailed)	0.876	0.324	0.114	0.447	0.313	0.238	0.219	0.785	0.572	0.808	0.612		0.884	0.669	0.179	0.447	0.076	0.000	0.219	0.008	0.003	0.179	0.100	0.052	0.050	0.226	0.958
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
25. Network_regional_UCCI (Unión de Ciudades Capitales Iberoamericanas)	Pearson Correlation	.309*	0.067	-0.055	-0.029	-0.157	-0.119	-0.038	0.011	-0.238	-0.246	-0.074	.b	-.349*	-0.192	0.176	-.341*	0.194	.515**	0.218	0.292	0.248	-0.104	.350*	-0.089	.542**	0.047	.501**	0.293
	Sig. (2-tailed)	0.041	0.667	0.722	0.849	0.308	0.443	0.808	0.945	0.120	0.107	0.634		0.020	0.211	0.252	0.024	0.207	0.000	0.156	0.055	0.105	0.501	0.020	0.568	0.000	0.764	0.001	0.054
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
26. Donor agency contribution to the development of plans	Pearson Correlation	.489**	0.232	-.305*	0.078	0.088	-0.015	0.206	0.089	0.025	0.104	0.014	.b	-0.224	0.160	0.184	-0.258	0.055	-0.222	0.206	-0.079	-.334*	-0.180	-0.026	-0.014	0.031	-0.137	-0.018	-.331*	0.011
	Sig. (2-tailed)	0.001	0.129	0.044	0.615	0.570	0.922	0.179	0.566	0.874	0.501	0.926		0.143	0.301	0.231	0.090	0.724	0.148	0.179	0.608	0.027	0.242	0.866	0.926	0.841	0.377	0.907	0.028	0.945
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
27. Environmentally-concerned civil society in the city	Pearson Correlation	0.073	0.241	-0.199	-0.106	-0.169	0.034	-0.205	0.021	-0.256	-.473**	-0.149	.b	-0.161	-0.072	0.097	-0.128	0.033	0.220	0.117	0.093	0.156	-0.021	0.272	-0.056	0.184	0.000	0.187	0.044	.374*	-0.097
	Sig. (2-tailed)	0.639	0.116	0.195	0.492	0.273	0.827	0.182	0.890	0.094	0.001	0.334		0.295	0.643	0.533	0.409	0.833	0.152	0.449	0.548	0.311	0.890	0.074	0.719	0.232	1.000	0.223	0.777	0.012	0.533
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
28. Population size	Pearson Correlation	0.104	0.020	0.051	-0.117	-0.036	0.103	0.033	-0.074	0.088	0.171	0.150	.b	0.150	0.036	0.093	0.044	.518**	.512**	0.216	0.157	.692**	.324*	0.277	0.161	.310*	0.201	0.109	.367*	0.294	-.342*	0.183
	Sig. (2-tailed)	0.500	0.896	0.744	0.449	0.819	0.507	0.834	0.633	0.571	0.267	0.330		0.332	0.817	0.550	0.778	0.000	0.000	0.159	0.308	0.000	0.032	0.069	0.298	0.041	0.191	0.482	0.014	0.052	0.023	0.234
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
29. Population growth rate	Pearson Correlation	0.193	0.134	-0.152	0.008	.471**	-0.070	-0.034	-0.032	0.145	0.044	-0.243	.b	0.000	.308*	0.110	.413**	-0.197	-.324*	-0.295	-0.249	-0.174	-0.097	-0.262	-0.117	-0.147	-0.049	0.004	-0.271	-.318*	0.071	-0.141	-0.239
	Sig. (2-tailed)	0.210	0.387	0.323	0.960	0.001	0.653	0.829	0.835	0.347	0.777	0.112		1.000	0.042	0.477	0.005	0.199	0.032	0.052	0.104	0.258	0.530	0.086	0.449	0.340	0.751	0.981	0.076	0.036	0.646	0.362	0.118
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
30. Population density	Pearson Correlation	0.254	0.003	-0.034	0.050	0.075	-.383*	0.134	.337*	0.116	.322*	0.138	.b	-.345*	-0.134	.404**	0.079	0.141	0.159	0.084	0.184	.319*	0.020	0.190	-0.123	0.018	-0.153	0.064	0.187	0.168	-0.047	-0.207	0.214	0.070
	Sig. (2-tailed)	0.096	0.985	0.825	0.749	0.629	0.010	0.386	0.025	0.452	0.033	0.373		0.022	0.384	0.007	0.611	0.360	0.304	0.588	0.233	0.035	0.899	0.216	0.428	0.909	0.322	0.680	0.225	0.276	0.763	0.178	0.163	0.651
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
31. City-level GDP per capita	Pearson Correlation	0.166	0.279	-0.128	-0.288	-.390**	-0.042	-0.102	-0.098	-0.126	-0.092	0.244	.b	-0.210	-0.274	0.065	-0.235	.304*	.341*	0.219	0.292	0.208	-0.205	.342*	-0.119	.321*	0.136	0.168	0.124	.438**	-0.152	0.242	0.258	.461**	-0.063
	Sig. (2-tailed)	0.282	0.067	0.408	0.058	0.009	0.787	0.512	0.526	0.416	0.554	0.111		0.172	0.072	0.674	0.125	0.045	0.023	0.153	0.054	0.175	0.182	0.023	0.441	0.034	0.378	0.275	0.424	0.003	0.325	0.113	0.091	0.002	0.685
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
32. Gini Coefficient	Pearson Correlation	-0.142	-.363*	0.184	.339*	.358*	0.199	0.221	-.510**	0.180	.700**	-0.033	.b	.346*	0.227	-0.173	-0.060	0.213	0.194	0.216	0.136	0.075	0.276	0.116	.407**	.378*	.349*	-0.012	-0.048	-0.034	0.178	-0.253	0.071	0.075	-0.059	-0.261
	Sig. (2-tailed)	0.371	0.018	0.244	0.028	0.020	0.207	0.160	0.001	0.255	0.000	0.836		0.025	0.148	0.273	0.707	0.176	0.219	0.170	0.391	0.637	0.077	0.465	0.007	0.014	0.023	0.938	0.765	0.830	0.261	0.105	0.656	0.637	0.710	0.095
	N	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
33. Unemployment rate	Pearson Correlation	0.188	-0.092	-0.066	0.258	-0.062	-.488**	-0.076	-0.171	-0.086	.495**	-0.053	.b	-0.249	-0.130	0.038	-0.117	0.223	0.239	0.107	.377*	0.053	-0.098	0.271	0.051	.331*	0.271	0.127	-0.046	0.190	0.091	-0.163	0.004	-0.076	.559**	0.063	.407**
	Sig. (2-tailed)	0.233	0.561	0.678	0.099	0.697	0.001	0.631	0.279	0.590	0.001	0.740		0.111	0.414	0.811	0.461	0.156	0.127	0.498	0.014	0.741	0.538	0.083	0.747	0.032	0.082	0.424	0.771	0.229	0.567	0.302	0.979	0.632	0.000	0.692	0.008
	N	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	41
34. CO2 emission per capita	Pearson Correlation	0.068	0.139	-0.028	-0.188	-.576**	0.004	-0.250	-0.113	-0.255	-0.275	0.289	.b	-0.165	-.319*	0.053	-0.085	0.061	0.118	.346*	0.151	-0.136	-0.008	0.265	-0.010	0.082	0.019	-0.079	-0.094	0.192	0.054	0.110	-0.047	-.461**	-0.214	.570**	-.338*	-0.170
	Sig. (2-tailed)	0.676	0.392	0.864	0.245	0.000	0.980	0.120	0.486	0.113	0.085	0.070		0.308	0.045	0.745	0.602	0.709	0.470	0.029	0.352	0.401	0.961	0.098	0.951	0.616	0.907	0.630	0.563	0.235	0.743	0.498	0.774	0.003	0.185	0.000	0.033	0.294
	N	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
35. Proximity to coast	Pearson Correlation	-0.058	0.162	-0.050	-0.207	0.069	-0.209	-0.214	-0.212	-0.045	-0.058	-0.210	.b	-0.034	0.125	-0.069	0.186	-0.001	-0.130	-0.202	-0.286	-0.207	-0.019	-0.272	-0.138	0.051	0.196	0.172	-0.129	-0.063	-0.150	0.072	-0.096	.439**	-0.225	-0.087	0.032	-0.139	-0.168
	Sig. (2-tailed)	0.706	0.293	0.749	0.177	0.658	0.174	0.163	0.166	0.769	0.711	0.170		0.829	0.418	0.655	0.227	0.992	0.402	0.189	0.060	0.178	0.903	0.074	0.371	0.741	0.202	0.265	0.404	0.682	0.330	0.641	0.533	0.003	0.143	0.576	0.839	0.380	0.300
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	42	42	40
36. Coastal city	Pearson Correlation	0.060	-0.239	0.137	0.202	0.091	0.182	0.297	-0.031	0.021	0.159	0.046	.b	0.062	0.104	-0.067	-0.202	0.027	-0.027	0.030	0.137	-0.090	-0.262	0.056	0.123	0.152	0.000	-0.129	0.103	0.159	0.262	-.311*	-0.095	-0.158	0.029	-0.008	0.241	0.250	0.007	-.577**
	Sig. (2-tailed)	0.698	0.118	0.374	0.188	0.558	0.236	0.050	0.841	0.892	0.301	0.765		0.688	0.501	0.667	0.188	0.862	0.859	0.845	0.374	0.563	0.086	0.716	0.425	0.323	1.000	0.403	0.505	0.301	0.086	0.040	0.538	0.304	0.850	0.960	0.124	0.110	0.965	0.000
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	42	42	40	44
37. Distance from equator	Pearson Correlation	0.025	0.159	-0.031	-0.229	-.377*	0.046	-0.262	-0.013	-.365*	-0.245	-0.095	.b	0.054	0.144	-0.126	-0.097	0.254	-0.007	-0.078	0.017	-0.066	-0.183	-0.001	-0.035	0.008	0.280	-0.168	-0.119	-0.092	0.023	.315*	0.095	-0.205	-.537**	0.226	-0.226	-0.307	0.200	0.034	-0.113
	Sig. (2-tailed)	0.873	0.315	0.846	0.144	0.014	0.770	0.093	0.934	0.017	0.118	0.552		0.734	0.361	0.425	0.542	0.104	0.964	0.621	0.916	0.677	0.247	0.997	0.828	0.959	0.072	0.287	0.452	0.563	0.884	0.042	0.551	0.193	0.000	0.149	0.160	0.051	0.222	0.833	0.476
	N	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	40	41	39	42	42
38. Altitude above sea level	Pearson Correlation	0.145	0.276	-0.201	-0.167	0.221	-0.069	-0.103	0.201	0.060	-0.241	-0.229	.b	-0.151	0.008	0.203	0.101	-0.241	-0.005	-0.018	-0.147	0.106	0.288	-0.072	-0.164	-0.169	-0.277	.319*	0.073	0.022	-0.098	0.263	0.032	0.122	0.113	-0.184	-0.145	-0.207	-0.272	0.275	-.589**	-0.275
	Sig. (2-tailed)	0.347	0.069	0.191	0.278	0.150	0.658	0.506	0.191	0.698	0.114	0.134		0.329	0.957	0.187	0.513	0.114	0.976	0.907	0.342	0.494	0.058	0.643	0.287	0.273	0.069	0.035	0.636	0.886	0.525	0.085	0.835	0.430	0.466	0.231	0.358	0.187	0.090	0.071	0.000	0.078
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	42	42	40	44	44	42
39. Average temperature of warmest month	Pearson Correlation	-0.260	-0.291	0.212	0.175	-0.176	0.049	0.038	-0.181	-0.066	0.083	0.167	.b	0.247	-0.051	-0.280	0.001	-0.017	-0.228	-0.108	0.023	-0.290	-.323*	-0.091	0.095	-0.037	0.130	-.430**	-0.187	-0.214	0.049	-0.224	-0.178	-0.023	-0.219	-0.043	0.110	0.105	0.262	-0.122	.405**	0.188	-.831**
	Sig. (2-tailed)	0.089	0.055	0.167	0.256	0.253	0.750	0.807	0.241	0.668	0.594	0.277		0.107	0.741	0.065	0.993	0.914	0.136	0.485	0.884	0.057	0.033	0.557	0.540	0.811	0.400	0.004	0.224	0.163	0.753	0.145	0.247	0.883	0.153	0.782	0.488	0.510	0.102	0.431	0.006	0.234	0.000
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	42	42	40	44	44	42	44
40. Average temperature of coldest month	Pearson Correlation	-0.216	-.413**	0.294	0.261	0.208	0.039	.348*	-0.069	0.252	.354*	0.244	.b	0.207	-0.104	-0.036	0.031	-0.128	-0.160	0.045	0.069	-0.199	-0.130	0.025	0.140	-0.051	-0.146	-0.255	-0.054	-0.076	0.085	-.422**	-0.178	0.055	0.264	-0.225	.365*	.407**	-0.010	-0.233	.466**	-.579**	-.460**	.616**
	Sig. (2-tailed)	0.158	0.005	0.053	0.087	0.175	0.800	0.020	0.658	0.099	0.018	0.110		0.177	0.501	0.818	0.842	0.409	0.299	0.773	0.656	0.195	0.399	0.871	0.364	0.744	0.346	0.094	0.727	0.625	0.584	0.004	0.247	0.722	0.084	0.143	0.017	0.007	0.952	0.127	0.001	0.000	0.002	0.000
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	42	42	40	44	44	42	44	44
41. Total amount of rainfall	Pearson Correlation	-0.066	-0.297	0.130	.317*	0.118	0.035	0.272	-.368*	0.189	.476**	0.199	.b	0.190	0.052	-0.135	-0.022	0.016	0.162	.323*	0.250	0.001	0.159	0.196	0.205	0.224	0.098	0.031	-0.030	-0.038	0.162	-0.230	-0.015	-0.050	0.045	0.048	.556**	.353*	0.025	-0.073	.318*	-.365*	-.385**	.347*	.627**
	Sig. (2-tailed)	0.673	0.050	0.402	0.036	0.445	0.821	0.074	0.014	0.220	0.001	0.196		0.216	0.737	0.381	0.889	0.919	0.295	0.033	0.101	0.995	0.303	0.203	0.181	0.143	0.526	0.841	0.845	0.805	0.294	0.132	0.921	0.749	0.774	0.756	0.000	0.022	0.879	0.636	0.035	0.018	0.010	0.021	0.000
	N	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	42	42	40	44	44	42	44	44	44
42. Number of rainy days	Pearson Correlation	0.068	-0.130	-0.007	0.238	0.206	-0.072	0.185	-0.273	0.221	.584**	0.092	.b	0.010	-0.087	0.061	0.271	0.056	0.287	0.299	0.267	.325*	.323*	0.224	0.160	0.245	0.162	0.105	0.221	-0.043	-0.036	-0.304	0.130	0.059	.531**	-0.086	.451**	.437**	-0.171	-0.088	0.136	-.666**	0.029	-0.149	.407**	.735**
	Sig. (2-tailed)	0.670	0.413	0.967	0.129	0.190	0.652	0.242	0.080	0.160	0.000	0.562		0.949	0.583	0.702	0.083	0.723	0.066	0.054	0.087	0.036	0.037	0.154	0.311	0.118	0.306	0.507	0.160	0.788	0.820	0.050	0.413	0.709	0.000	0.588	0.003	0.005	0.306	0.580	0.391	0.000	0.855	0.346	0.008	0.000
	N	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	40	40	38	42	42	40	42	42	42	42

**Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

b National-level governance structure: Cannot be computed because at least one of the variables is constant.

Table A6. Climate/Sustainable development policy programs/projects assisted by international organizations in top 10 cities of the IMA index.

City (Country)	Program/Project (in local language)	(in English)	Organizations	Integrated elements
Asuncion (Paraguay), Florianopolis (Brazil), Mendoza (Argentina), and Panama City (Panama)	Ciudades Emergentes y Sostenibles (CES)	Emerging and Sustainable Cities (ESC)	Inter-American Development Bank (IDB)	Implemented according to the methodology of 5 steps across the development and execution of action plans including diagnostic analysis of climate change addressing mitigation and adaptation together
Bogota (Colombia)	Plan regional integral de cambio climático de Bogotá - Cundinamarca	Integral regional plan of climate change in Bogota - Cundinamarca	United Nations Development Programme (UNDP)	Implemented an interinstitutional platform for climate-related decision-making dealing with M+A together
Cali (Colombia)	N/A	N/A	International Center for Tropical Agriculture (in Spanish 'Centro Internacional de Agricultura Tropical-CIAT')	The plan was developed based on the agreement between CIAT and local institutions 'Convenio CVC-CIAT-DAGMA No. 67 de 2016' aiming to join forces and economic, technical and human resources for developing actions in the framework of climate change mitigation and adaptation in the municipality of Santiago de Cali
Cartagena (Colombia)	Proyecto integración de la adaptación al cambio climático en la planificación territorial y gestión sectorial de Cartagena de Indias	Project for integration of adaptation to climate change in the territorial planning and sectoral administration of Cartagena de Indias	CDKN (The Climate and Development Knowledge Network) and funded by DFID and DGIS	'Plan 4C is a framework for planning and action in response to the need for a more climate compatible development[a]' by providing measures of adaptation in addition to mitigation
Montevideo (Uruguay)	Cambio Climático Territorial—Desarrollo local resiliente al cambio climático y de bajas emisiones de carbono en los departamentos de Canelones, Montevideo y San José	Territorial climate change—Local development resilient to climate change and of low carbon emissions in Canelones, Montevideo and San Jose	UNDP, Quebec gov. and Vasco gov.	A framework of sustainable development with the participation of institutions and citizens contributing to the knowledge dissemination and the identification of risks and opportunities related to climate change and adopting the integrative approach to mitigation and adaptation[b]

[a] Office of the Mayor of Cartagena de Indias, MADS, INVEMAR, CDKN and Cartagena Chamber of Commerce. 2014. Plan 4C: A Competitive and Climate Compatible Cartagena, p 20.
[b] UNDP, Plan Climático de la Región Metropolitana de Uruguay, p 31.

Table A7. Brazil and Mexico national climate fund.

Country	Sub-programs	Mitigation/Adaptation
Brazil	• Urban mobility	Mitigation
	• Sustainable cities and climate change	Integrated (Mitigation driven)*
	• Efficient machinery and equipment	Mitigation
	• Renewable energies	Mitigation
	• Solid waste	Mitigation
	• Charcoal	Mitigation
	• Combating desertification	Adaptation
	• Native forests	Integrated
	• Carbon management	Mitigation
	• Innovative projects	Integrated
Mexico	• Joint project for mitigation and adaptation	Integrated
	• Adaptation actions	Adaptation
	• Mitigation actions	Mitigation
	• Education program	N/A
	• Research and evaluations of national system on climate change	N/A
	• Research, innovation, and technology development and transfer	N/A

Source: ECLAC, GIZ and IPEA (2016)[a], BNDES official website[b], and SEMARNAT (2016)[c].

[a] ECLAC, GIZ and ipea 2016. Avaliação do fundo clima. United Nations Economic Commission for Latin America and the Caribbean. Available at: https://repositorio.cepal.org/bitstream/handle/11362/40843/1/S1601337_pt.pdf.

[b] Accessed: 9 December 2018.

[c] SEMARNAT, 2016. Fondo para el cambio climático: Mexico. ECLAC. Available at: https://cepal.org/sites/default/files/events/files/fondo_para_el_cambio_climatico_2016_mexico.pdf.

* Climate change in this sub-program means mainly mitigation since it aims 'to increase cities' sustainability, to improve energy efficiency, and to reduce energy consumption and natural resources.' (BNDES official website, accessed: 9 December 2018).

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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