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How are Italian and Spanish cities tackling climate change? A local comparative study

Marta Olazabal*[a,b], Sonia De Gregorio Hurtado[c], Eduardo Olazabal[d], Filomena Pietrapertosa[e], Monica Salvia[e], Davide Geneletti[f], Valentina D'Alonzo[f], Efrén Feliú[g], Senatro Di Leo[e], Diana Reckien[h]

Cities are widely recognised as being pivotal to fight climate change. They magnify the drivers of climate change, experience the impacts and also concentrate the highest room for action. Although urban areas are broadly claimed to be climate leaders, there is no archetype of right actions given the highly contextual differences among them. Yet, the how and why cities respond to global environmental challenges in the context of increasingly competitive economies needs further research. In this paper we aim at advancing in this regard by assessing the state of the art on urban climate actions in two European Mediterranean Countries: Spain and Italy that face similar climate change challenges. Based on an extensive review of documents, we analyse mitigation and adaptation plans of 26 Spanish and 32 Italian Urban Audit cities, as representative samples. Our results show relevant differences between Spanish and Italian cities in terms of the starting time of their climate actions as well their implementation. We concur with existing literature in that mitigation is more advanced than adaptation actions and take evidence in both countries and we also demonstrate that international and national networking initiatives are being instrumental in engaging cities in climate action.

Keywords: urban climate action; mitigation plan; adaptation plan; Spain; Italy; Urban Audit

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1. Introduction

Now more than ever, urban areas are pivotal to global climate change adaptation and mitigation efforts (Acuto 2013, 2013; Reckien et al. 2014; Rosenzweig et al. 2010) due to intrinsic characteristics of urban development. The high level of social and economic vulnerability of cities is mainly caused by urbanization patterns (Garschagen and Romero-Lankao, in press), the growing concentration of population in cities (UN 2011), and the concentration of services and critical infrastructures in urban-region areas (Reckien et al. 2014). At the same time, cities are responsible for a relevant share of the emissions inducing climate change (Dhakal 2010). Urban form, structure, building characteristics and consumption patterns have a decisive role in resource use in cities, and the need to focus on its reduction is increasingly recognised (Weisz and Steinberger 2010).

Based on a selection of city case studies across the world, the First Assessment report on Climate Change and Cities of the Urban Climate Change Research Network (UCCRN) (Rosenzweig et al. 2011) argues that the most important sectors expected to suffer the impacts of climate change in most cities are: (i) the local energy system; (ii) water supply, demand, and wastewater treatment (iii) transportation; and (iv) public health. Not only because infrastructures that provide these services need to be adapted to the impacts of climate change (EC 2013a) (such as for example, adaptive capacity of water infrastructures in storm prone urban areas), but also because new challenges may arise (such as with regard to health risks). Additionally, cities need to face further cross-cutting challenges related to governance and planning, land use management and green infrastructure as these might considerably magnify or reduce the impacts of climate change (Blanco et al. 2011). These issues which include the study of the implications of land markets, property rights and fiscal and legal issues (e.g. flooding risks impacts on housing insurance market in Denmark and UK), have been poorly addressed up to date and have a great impact on the potential of climate change strategies (Blanco et al. 2011).

Although cities are widely claimed to be climate leaders (Rosenzweig et al. 2010) there being good examples of successful climate actions (Castán Broto and Bulkeley 2013; Rosenzweig et al. 2011), there is no archetype of right actions given the highly contextual differences among cities. The how and why cities respond to global environmental challenges in the context of increasingly competitive economies needs further research (Acuto 2013; Johnson 2013).

While historically the efforts have been focused on mitigation, the challenge must be dual (Blanco et al. 2009) since adapting to the accumulating climate impacts is urgent. Many important networks and alliances such as C40 cities[1] and the Covenant of Mayors[2] (committed to energy sustainability), have arisen to lead the way towards sustainability and resilience to climate change. However, most of the work so far focuses on mitigating rather than adaptation.

Regarding the responsibility to act, adaptation should be developed and undertaken by local authorities (Measham et al. 2011), as it is at the local level where the impacts are experienced and where the complexities are better recognized (Swart et al. 2009) although national and regional policies must coordinate cross-scales interactions and sectoral strategies (EC 2013b),

Yet, the integration of climate change in urban planning is still a challenge with respect to mitigation and to adaptation objectives (Blanco et al. 2011). Most of it might have to do with the lack of engagement of planners in climate networks and with the short-term approach of local plans which cannot suit the long term perspective needed in climate strategies (Wilson 2006).

[1] http://www.c40cities.org/ (Last Accessed November 8, 2013).
[2] http://www.covenantofmayors.eu/ (Last Accessed November 8, 2013).

In this paper we aim at advancing the understanding on how and why cities are responding to climate change (Johnson 2013) by assessing the state of the art on urban climate action in two European Mediterranean Countries: Spain and Italy. This research and its results have been used to feed a multilevel climate governance comparison between the two countries undertaken by the authors (De Gregorio Hurtado et al. 2014).

Italy and Spain experience similar climate change drivers and impacts, and share similar Mediterranean climatic conditions. The level of vulnerability to climate change in both countries is also comparable as indicated by the ESPON vulnerability index (ESPON et al. 2011). Additionally, governance and planning culture and economic context might be seen as comparable. These similarities provide a context where any finding from our analysis can be identified and explained from an institutional or cultural point of view. Regarding the EU climate policy, both countries have developed similar approach towards the EU climate policy (Wurzel and Connelly 2011). Therefore, we hypothesize that cities of both countries face similar climate change challenges and risks and, therefore, could have developed similar efforts (financial, administrative, political, technical, etc.) in order to implement efficient climate policies.

The paper is structured as follows: Section 2 describes the data used and the analytical process followed to explore urban climate action in Italian and Spanish cities. Section 3 covers the case of Spanish cities. Section 4 covers the case of Italian cities. Section 5 discusses and compares the results. Section 6 concludes.

2. Data and method

We undertook a thorough review of local climate action[3] in a representative sample of Italian and Spanish cities. The sample comprises the most important, large and medium-sized cities of the two countries that are included in the Urban Audit (UA) database[4], building on the work by Reckien et al. (2014). The database comprises local climate actions of a representative sample of 200 cities in 11 EU countries. All in all, Climate Change Mitigation and Adaptation plans[5] (CCM and CCA respectively) of 32 Italian and 26 Spanish cities included in the UA database (Fig. 1) have been analysed.

The Italian sample covers 18.3%[6] of the total Italian population and the Spanish sample covers 27%[7] of the country's population. Moreover, UA cities are assumed to be a balanced and regionally representative sample of cities across Europe. We, thus, assume that this is a representative national sample of the Italian and Spanish cities.

[3] As of January 2013.

[4] The UA database is built by the European Commission, Eurostat and the national statistical offices. UA cities comply with the following criteria: 1) approximately 20% of the national population ought to be covered; 2) national capitals and, where possible, regional capitals are to be included; 3) large (more than 250,000 people) and medium-sized urban areas (minimum 50,000 and maximum 250,000 population) are to be included; and 4) urban areas should be geographically dispersed within countries. UA cities are assumed to be a balanced and regionally representative sample of cities across Europe. The entire UA database comprises 357 cities across 30 pan-European countries: 329 variables (on matters such as demography, society, the economy, the environment, transport, the information society and leisure) are collected. The database is updated every three years. URL: http://www.urbanaudit.org/ (Accessed date: November 20, 2013).

[5] Adaptation plans incorporate actions that lead to the abatement or reduction of vulnerability to climate change; mitigation plans encompass actions that entail a reduction of greenhouse gas emissions. (Reckien et al. 2014).

[6] Data source: Italian Institute of Statistics (ISTAT). URL: http://demo.istat.it/index.html (Accessed date: September 30, 2013).

[7] Data source: Instituto Nacional de Estadistica (INE) URL: http://www.ine.es/en/ (Accessed date: May 16, 2013).

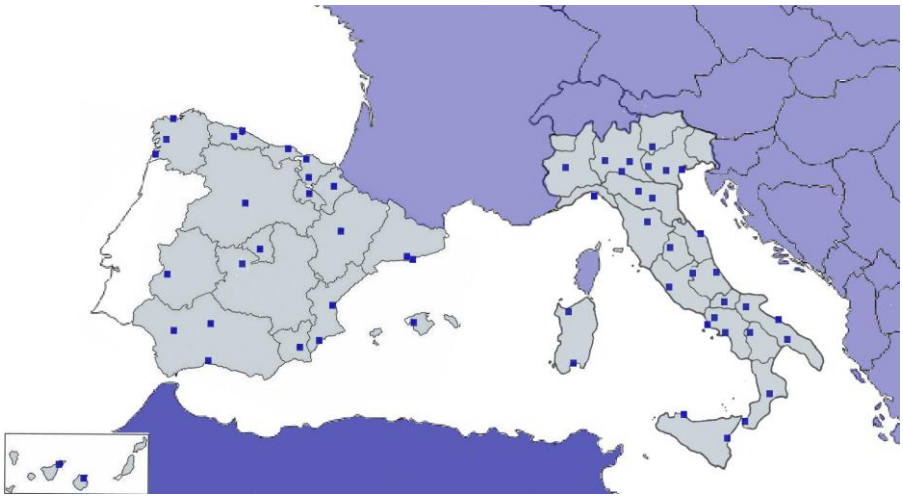

Figure 1: Italian and Spanish cities analysed. Source: self-elaboration.

Our database include plans where climate change was explicitly the motivation for their development (as in Reckien et al. 2014), as well as Climate Change Mitigation and Adaptation *Related* plans and programmes (CCMR and CCAR respectively). This means that, when local adaptation and mitigation plans had not been specifically developed in the sample cities, we identified plans containing supportive mitigation and adaptation measures (such as in the case of mitigation, local energy plans not mentioning climate change specifically or, in the case of adaptation, for example, heat waves plans). The same criteria described in Reckien et al. (2014) was followed to collect the documents:

- type of documents: Urban climate change strategic policy and planning documents approved, published, or in development (if a draft was made available);
- spatial coverage: A document was considered relevant if it covered the entire urban area or city region;
- collection method: First, Internet search. If no documents were available online, city administration officers were contacted to confirm that no plan existed or to request a draft if it was under development or not published yet.

As put by Reckien et al. (2014) "we analysed the plans without relying on self-assessment of city representatives", which allows a more scientifically rigorous analysis.

The information, as of January 2013, regarding such plans (status, year of approval, topics covered and emission reduction commitments) has been systematized in a database together with the information on the cities' networking membership. We provide descriptive statistics for a number of indicators of these issues. Table A1 (Spanish UA cities) and A2 (Italian UA cities), in the Annex lists the cities and the respective plans used for this analysis.

Among the indicators collected, we gathered information regarding the emission reduction targets included in the plans. All Spanish cities provide emission targets in % of CO_2 equivalent (henceforth, CO_2e). All Italian cities, in contrast, (except Rome) provide emission targets in % of CO_2. Figures in CO_2e account for the mix of greenhouse gases using the Global Warming Potential (GWP) of the CO_2 as the reference (see Forster et al. 2007). According to the latest statistics by Eurostat[8], "carbon dioxide accounted for 82.4% of EU-27 greenhouse gas emissions in 2010, followed by methane (8.5%), nitrous oxide (7.1%) and fluorinated gases (2.0%)". Cerutti et al. (2013) argue that this can be used to justify a reliable comparison of both metrics, although understanding

[8] Eurostat Climate Change Statistics. URL: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Climate_change_statistics (Last accessed December 3, 2013).

that other gases emissions are underestimated if accounting only tonnes of CO_2. Assuming that no emission abatement measure can reduce only CO_2, in this paper, we use these metrics as comparable to contrast the dimension and ambitiousness of the Italian and Spanish local mitigation projects.

Results of this study are used to support conclusions of the main comparative study in De Gregorio Hurtado et al. (2014) published under the BC3 Working Paper Series.

3. Assessment of urban climate action in Spain

3.1 Mitigation

In Kyoto Protocol, Spain committed to keep its emissions up to a 15% above the emissions of 2002 in the period 2008-2012. Observing the situation and the factual breach of agreement, the Spanish Government, through the Federation of Municipalities and provinces in Spain (FEMP), called for action at local scale (FEMP 2009). Earlier in 2004, the Network of Spanish Cities for Climate (or RECC)[9] was formed. A guide to develop local strategies for climate change was published through the Network of Spanish Cities for Climate (RECC 2011) in a joint effort of the Office of Climate Change in Spain part of the Ministry of Agriculture and Environment, and the FEMP. The network was formed in 2004. 291 municipalities were members of the network in 2011 (RECC 2012). The published guide (and many other reports to be found in the network's website) is quite detailed in its direction on how to build action strategies and measures coherent with the competencies of municipalities in Spain. The last annual report (RECC 2012) reports that 46% of the municipalities belonging to the network have initiated policies and strategies. Also it is reported, that there has been an average reduction of 5.81% in the GHG emissions from 2005 to 2010 as reported by the municipalities belonging to the network.

During the last decade, many municipalities have joined the efforts by developing plans and strategies on climate change, sustainable energy or sustainable mobility. Until May 2013 there were 857 Sustainable Energy Action Plans developed by Spanish municipalities from a total of 998 Spanish signatories of CoM. They represent 10.5% of the total municipalities in Spain. Only 3.2% of them (Fig. 2) have themselves committed to decrease emissions by more than 40% by 2020. The great majority has itself committed to decrease CO_2 emissions by between 20 and 40%. The latter can be seen as a quite conformable for policy making as there are already many on-going initiatives, e.g. on mobility and energy efficiency that make it easy to comply with the pre-requisite of joining the Covenant of Mayors, i.e. reducing GHG emissions by 20%.

Regarding the detailed analysis of the 26 Spanish cities in our sample, 54% of them have approved their CCM plans. 23% are in the process to develop one and another 23% has no intention to do so, at least in the short term (according to personal communications of the city officers to the research team). All of the documents considered in this case are CCM (no CCMR has been identified).

Table 1 shows the year of adhesion of cities to international (CoM) or national (RECC) networks and the year of approval of the plan (when existing). It is interesting to note how the adhesion to RECC has not been very important in the development of the plans, but the adhesion to the Covenant of Mayors has been crucial[10]. Nonetheless, cities, like Bilbao or Vitoria, have previous plans that have evolved and been approved on the date Table 1 shows.

[9] http://www.redciudadesclima.es/ (Last Accessed November 8, 2013).
[10] Most cities mention the CoM in their plans as a push to develop the plan (many of them have the CoM logo in the cover).

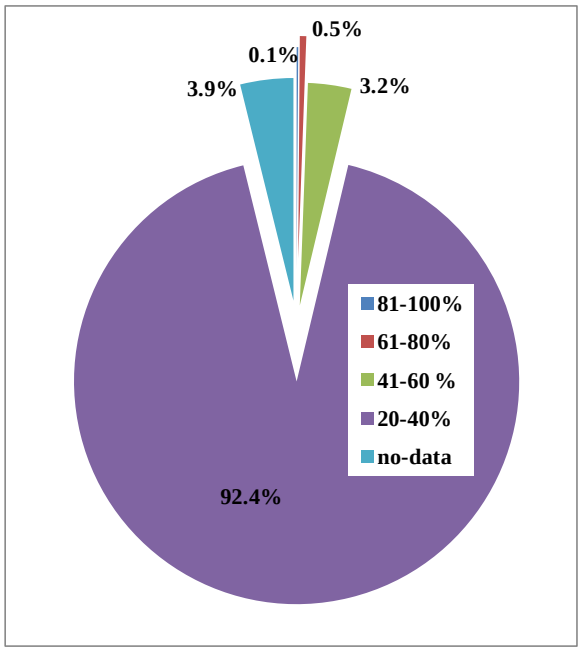

Figure 2: CO_2 reduction targets in Spanish cities signatories of the Covenant of Mayors (as of May 2013). Data source: www.eumayors.eu

Table 1: Year of adhesion to international (CoM) or national (RECC) climate networks and year of approval of the mitigation or mitigation-related plan (as of June 2013).

	2005	2006	2007	2008	2009	2010	2011	2012	2013
Alicante/Alacant					RECC				
Badajoz									CoM
Barcelona	RECC			CoM			PLAN		
Bilbao						CoM		PLAN	
Córdoba			RECC		CoM	PLAN			
Coruña, A	RECC							CoM	
Gijón	RECC						CoM		
Las Palmas	RECC								
L'Hospitalet de Llobregat		RECC		CoM		PLAN			
Logroño				RECC				CoM	
Madrid	RECC			CoM PLAN					
Málaga	RECC			CoM		PLAN			
Murcia	RECC			CoM PLAN					
Oviedo	RECC								
Palma de Mallorca	RECC								
Pamplona/Iruña				RECC	CoM		PLAN		
Santa Cruz de Tenerife			RECC						
Santander	RECC			CoM		PLAN			
Santiago de Compostela									CoM
Sevilla	RECC				CoM	PLAN			
Toledo					RECC				
Valencia				RECC	CoM	PLAN			

Valladolid	RECC						CoM	PLAN	
Vigo			RECC						
Vitoria/Gasteiz	RECC			CoM		PLAN			
Zaragoza	RECC					PLAN	CoM		

Figure 3 shows the late evolution of plans approval of Spanish UA cities (as of January 2013). Activity started in 2008, coinciding with the engagement of Spanish cities in the CoM network (Table 2).

Table 2: Topics most included in Spanish CCM plans.

Mitigation topic	**% of Spanish plans* addressing the topic**
Energy saving	**83.3**
Energy efficiency	**83.3**
Renewable energies	**77.8**
Heating from renewable energies	**11.1**
Waste management	**61.1**
Urban planning	**22.2**
Agriculture	**5.6**
Transportation	**72.2**
Intramunicipal reorganization	**11.1**
Buildings (e.g. Heating)	**83.3**

The CO_2e emission reduction targets of Spanish cities are shown in Figure 4. We only show those UA cities that set quantitative targets. Bilbao and Zaragoza are the most ambitious cities with a target of about 30% CO_2 emission reduction. Most cities set a reduction target of 20% until 2020, the compulsory target for the CoM agreement. Madrid set itself a target of 14% until 2012, so any follow-up plan must include a more ambitious target (there is no information available about the plan for the post 2012 period).

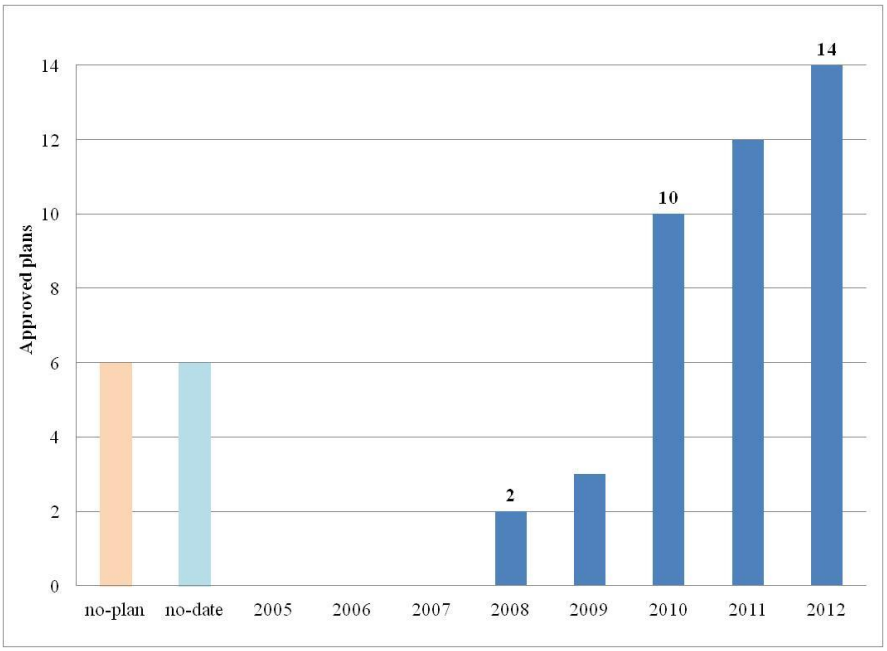

Figure 3: Evolution of the approval of plans in Spanish UA cities (as of January 2013). The figure shows accumulative data.

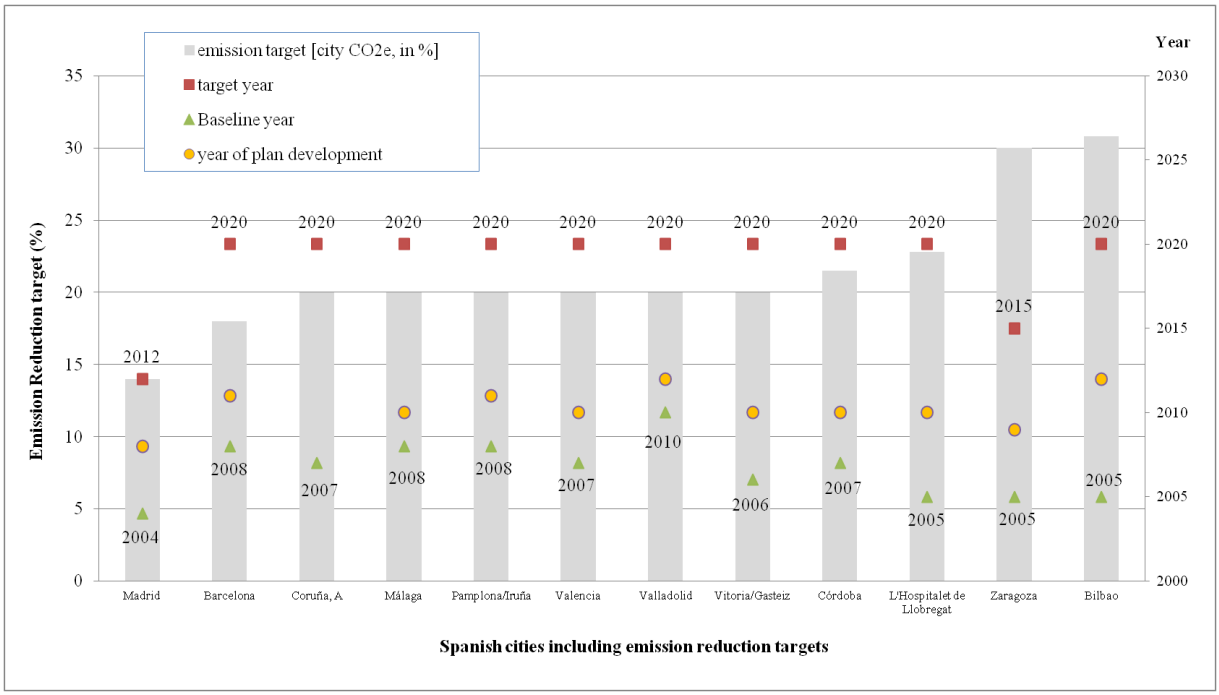

Figure 4: Emission reduction targets in Spanish UA cities that have set targets in their CCM or CCMR plans

Table 2 shows the topics that are covered in mitigation plans of Spanish cities when such documents were available. Most measures relate to energy in its multiple forms (energy saving, energy efficiency, introduction of renewable energies), while urban planning, intramunicipal reorganization, agriculture and heating from renewable energies are poorly covered.

3.2 Adaptation

According to the vulnerability index developed by ESPON (2011), 84% of the Spanish cities have a vulnerability index of 4 or higher, on a scale from 1 (low) to 5 (high). Despite the high vulnerability and existing national guidance on adaptation (i.e. RECC 2011), only 7 cities out of 26 studied (27%) have developed adaptation strategies to climate change, either in specific climate change adaptation plans (3) or integrated in mitigation or energy plans (4). All of them can be considered CCA. Among those plans, where adaptation is the only motivation for its development, only 1 is published and approved (Zaragoza), while 2 others are in early stages of development (either compiling information, e.g. Barcelona, or developing the diagnosis through vulnerability assessment and scenarios analysis e.g. Vitoria-Gasteiz).

Table 3 shows the topics most often covered in Spanish CCA plans. Water issues, such as water supply and floods management, together with health aspects are the topics most frequently addressed.

Table 3: Topics most included in Spanish CCA and CCAR plans

Adaptation topic	% of Spanish plans addressing the topic
Urban planning and development	42.9
Flood protection	57.1
Forest management	42.9
Agriculture	28.6
Water management	57.1
Health aspects	85.7

4. Assessment of urban climate action in Italy

4.1 Mitigation action

The *National Plan for the Containment of CO_2 Emissions* was approved in 1994 immediately after the Italian ratification of the United Nations Framework Convention on Climate Change, aiming at the stabilization of CO_2 emissions at the 1990 levels by the year 2000. Three years later, in 1997, the Country signed the Kyoto Protocol, committing to reduce its greenhouse gas emissions by 6.5% below the base-year levels (1990) over the first commitment period, 2008-2012.

Italy is the country with the largest share of cities integrated in the CoM network. This network has been instrumental in Italy and has led to the implementation of a large number of plans to mitigate to climate change at local level, many of them under the characteristic format of CoM, the Sustainable Energy Action Plan (SEAP). Out of 8092 municipalities, 2219 (27.4%) are signatories of the CoM (as of May 2013 and according to the CoM website) and around 62% of them have already submitted a Sustainable Energy Action Plan. As illustrated in Figure 5, the Italian CoM signatories have set highly ambitious CO_2 reduction targets: 1.2% has committed to decrease more that 80% of their emissions. Likewise, the great majority has committed to decrease between 20 and 40% its CO_2 emissions (58.5%). However, there is a great uncertainty given that, according to the Covenant of Majors website, there is no data yet on the emissions target in almost 38% of the Italian CoM signatories (as they have not yet submitted a plan according to the CoM website).

Considering emission reduction targets, Italian cities are more ambitions than their Spanish counterparts, given that targets above 60% (committed by almost 2% of the Italian signatories) are seen less often in Spanish cities (see Sect. 3). The other main network that is active in Italy is the Climate Alliance (CA)[11]. CA is an association of European municipalities and territorial authorities

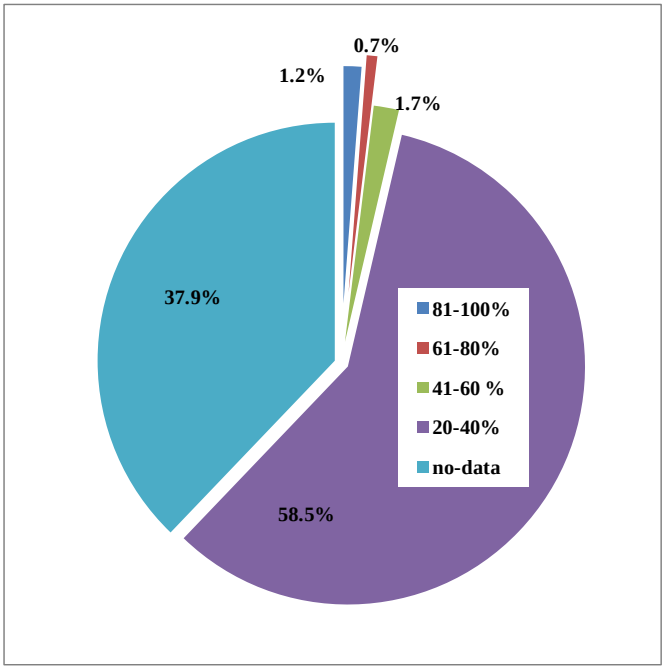

Figure 5: CO_2 reduction targets in the total of 2219 Italian Municipalities signatories of the Covenant of Mayors (as of May 2013). Data source: www.eumayors.eu

[11] The Climate Alliance is integrated by 1,600 European municipalities and local authorities who are committed to specific objectives. These voluntary commitments can be found on the Manifesto for the Alliance of European Cities with Indigenous Peoples of the Rainforests (Climate Alliance, 1990) and the Declaration for Climate (Climate Alliance, 2000). URL: http://www.klimabuendnis.org (Last accessed November 30, 2013).

engaged in a partnership with the indigenous people of the rainforests for the common goal of protecting global climate. In Italy, 166 municipalities and local authorities are members of the CA[12].

Regarding our sample, 19 out of 32 of the Italian UA cities included in our sample are signatories of the CoM. Only five have joined CA. We observe again how CoM is crucial in the development of CCM or CCMR plans in Italy.

Table 4: Year of adhesion to international climate networks (CoM and CA) and year of approval of CCM or CCMR plans (as of July 2013)

	(…)	**…**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Ancona						CoM			PLAN		
Bari									CoM	PLAN	
Bologna	PLAN (2002)					CoM					
Brescia					PLAN						
Cagliari										CoM	
Campobasso								CoM			
Caserta											CoM
Catania											
Catanzaro											
Cremona								CoM			
Firenze			CA		PLAN			CoM			
Foggia									PLAN		
Genova							CoM	PLAN			
L'Aquila									CoM PLAN		
Milano						CoM	PLAN				
Modena	CA (2002)							CoM	PLAN		
Napoli							CoM			PLAN	
Padova								CoM	PLAN		
Palermo	PLAN (2000)										
Perugia			PLAN				CA				
Pescara									CoM	PLAN	
Potenza	PLAN (1997)								CoM		
Reggio di Calabria											
Roma							CoM		PLAN		
Salerno								CoM		PLAN	
Sassari									CoM PLAN		
Taranto											

[12] In 2013, 120 Italian municipalities are ordinary members of the Alliance, 19 supra-local authorities are associate members (including Provinces, Mountain and Valley Communities and Regions) and 27 municipalities are associated.

Torino							CoM		PLAN		
Trento	CA (1995)				PLAN						
Trieste										CoM PLAN	
Venezia	CA (2003)								CoM	PLAN	
Verona						CoM					

25% of the Italian UA cities in our sample have not yet developed mitigation plans (CCM or CCMR). Currently, very few plans are in development: the great majority of cities that have developed a plan, have already approved it and published it. It seems that the most dynamic phase of development of mitigation and mitigation-relevant plans in Italy is already over. Some cities, such as Brescia, Palermo and Potenza have been forerunners in terms climate change mitigation, having developed mitigation or mitigation-relevant plans between 1997 and 2002 (see Fig. 6). The rest of the cities started their activity after 2005. The number of approved plans steadily increased since then, reaching 24 approved mitigation and mitigation-relevant plans in 2012. It is important to note that, 18 of these plans are CCM, the rest are CCMR (e.g. Cagliari, which has developed a plan to promote solar energy).

The CO_2 emission reduction targets set by Italian UA cities are shown in Figure 7. Only cities that set reduction targets (i.e. 18 out of 32 cities) are shown. Most of the cities have not been very ambitious. Torino (with the objective to reduce CO_2 by a 40% by 2020), Bari (on a 35% by the same year), and Brescia (that in 2002 committed to reduce by a 20% its emissions by 2006[13]) are the cities with the strongest commitments.

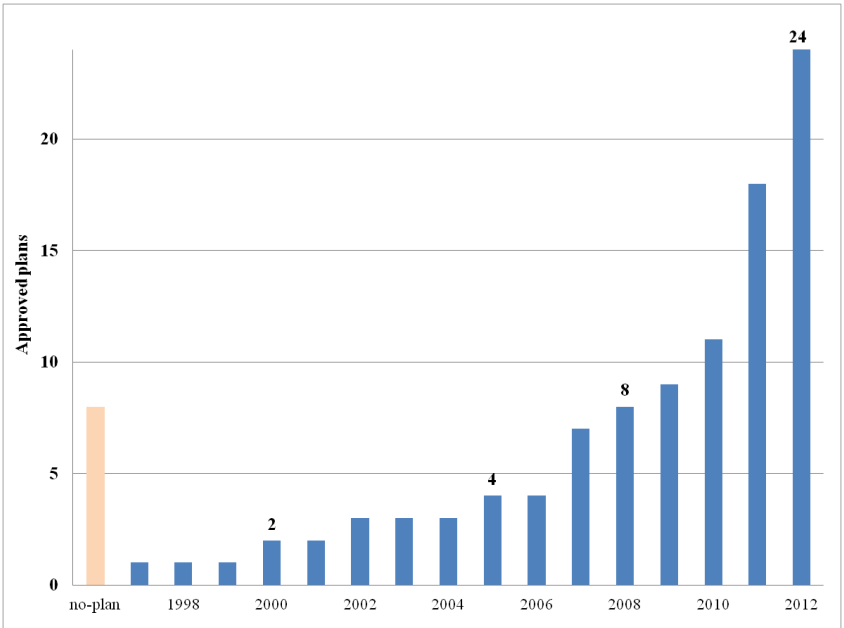

Figure 6: Evolution of the approval of plans in Italian UA cities (as of January 2013). The figure shows accumulative data.

[13] According to the City's website, the plan is still in force and there is no available information about whether if the plan succeded in its commitments in 2006 or not.

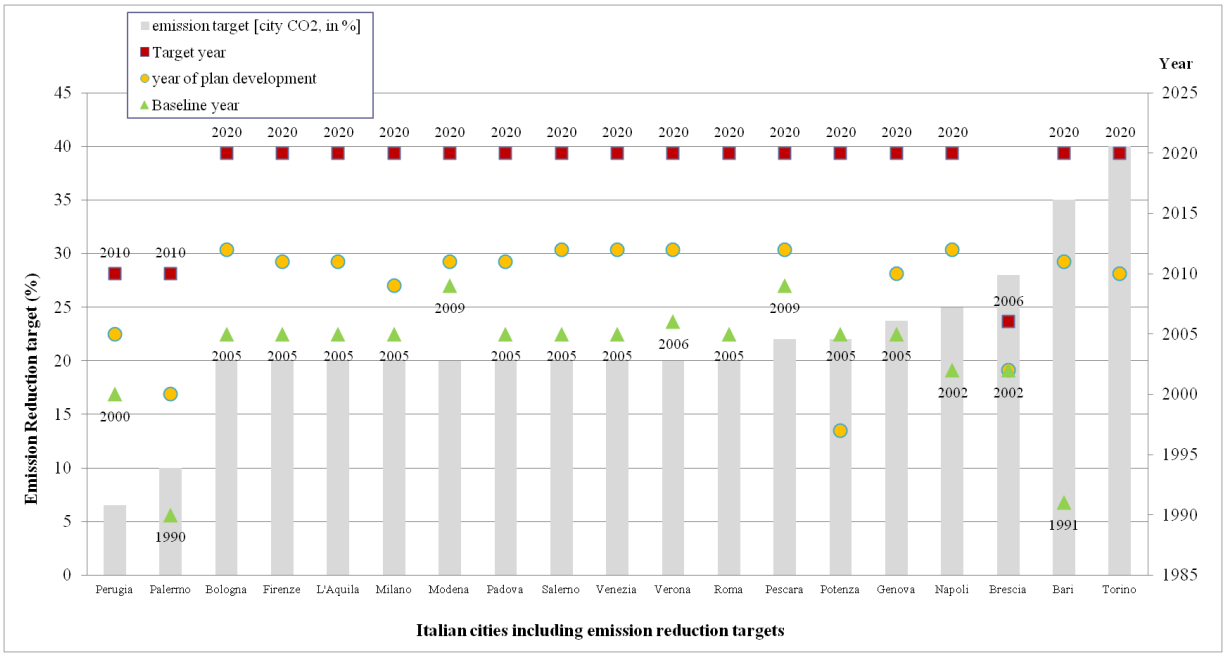

Figure 7: Emission reduction targets in Italian UA cities that have set any CO_2 reduction target.

Table 5 shows the topics most frequently included in Italian CCM and CCMR. Investment in buildings, renewable energies, and energy saving and efficiency are all planed frequently, while urban planning, waste management, and agriculture are the sectors least covered in CCM and CCMR plans in Italy.

Table 5: Topics most included in Italian CCM and CCMR plans

Mitigation topic	**% of Italian plans addressing the topic**
Energy saving	91,3
Energy efficiency	91,3
Renewable energies	95,7
Heating from renewable energies	91,3
Waste management	52,2
Urban planning	69,6
Agriculture	17,4
Transportation	87,0
Intramunicipal reorganization	69,6
Buildings (e.g. Heating)	100,0

4.2 Adaptation

Only 11 out of 32 cities included in this analysis have strategies developed that relate to climate change adaptation or influence the adaptive capacity of a city, despite high vulnerability levels (84% of the Italian cities have a vulnerability index of 4 or higher) according to ESPON (2011). Only 1 of the 11 (*Mitigation and Adaptation Plan of the city of Padova*) was designed with the purpose of addressing adaptation issues specifically, namely, a CCA plan. The rest of them are motivated by different issues, while containing climate adaptation measures (see Fig. 8). Remarkably, as shown in this figure, heat waves and hydro-geological risks are a big concern in Italian cities (62% of the plans have been developed with this motivation behind). In fact, as pointed out by the authors in De

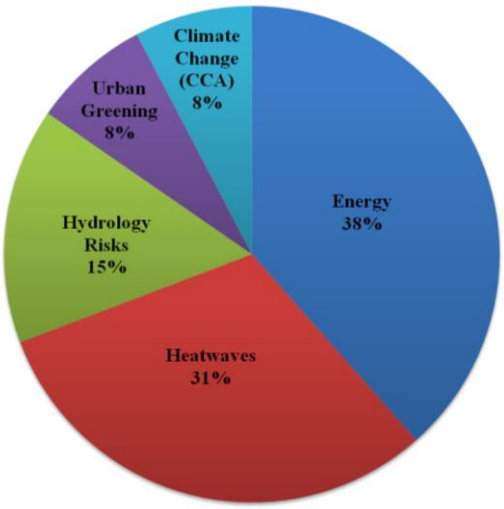

Figure 8: Context (motivation) of the plans related to adaptation in Italian UA cities.

Gregorio Hurtado et al. (2014), following the recommendation of the EU's Thematic Strategy on the urban environment, UPI (Union of Italian Provinces), ANCI (National Association of Italian Municipalities) and Local Agenda 21 propose a plan for coordination of actions in municipal plans where hydro-geological risks are included.

These cities have designed ad-hoc programmes, which in most of the cases are renewed every year, to help citizens to adapt to extreme temperature during the summer season (Catania, Milano, Perugia and Potenza). Two of these cities, Perugia and Catania have also developed strategies related to hydro-geological risks including floods, landslides, etc.

The topics most often addressed in these plans and strategies are health (in plans related to heat and hydrological risks), forest management measures (mostly in plans motivated by emissions reduction in energy plans) and urban planning and development (regarding codes and certification in plans related to sustainable energy) (see Table 6). Water management and floods protection are poorly covered, apparently, as these are issues legally pertaining to upper levels of governance (i.e. Regions). Agriculture is not addressed at all.

Table 6: Topics most included in Italian CCA and CCAR plans

Adaptation topic	**% of Italian plans addressing the topic**
Urban planning and development	30.8
Flood protection	15.4
Forest management	38.5
Agriculture	0.0
Water management	7.7
Health aspects	38.5

5. Discussion

Commitment to fight climate change is one first necessary step to start meaningful action. Affiliation to international or national climate networks is increasingly seen as an indicator of urban leadership in the fight against climate change (Johnson 2013; Rosenzweig et al. 2010).

Particularly in Italy and Spain, the authors (De Gregorio Hurtado et al. 2014) conclude that transnational climate action networks have had a greater impact on cities (particularly the large ones)

than the national policy, and particularly the CoM, have for both countries. Network membership in Italy and Spain in international (2219 Italian cities and 998 Spanish cities, in May 2013, have signed the CoM) and national initiatives, such as RECC in Spain, is relatively high. City alliances encourage local decision-makers to become active by providing the technical support that cities often do not receive otherwise. Sometimes, the membership also entails funding, through projects and initiatives or even directly. Regional initiatives, like RECC, seem more important for little- and medium-sized municipalities, while the big cities analysed seem to prefer joining an international network that brings international visibility and provides support to bid for European funds in partnership with foreign members of CoM.

Although the data on Italian and Spanish signatories of climate networks seem to align with the assumptions that urban leadership is growing, here we pose serious concerns about the significance of these commitments. For example, around 96% of the Italian and also of the Spanish signatories of the CoM have either an emission reduction target close to 20% (minimum for the agreement) or has not officially committed to any target yet (in the case of Italy, around 40% of the signatories).

Nevertheless, other roles of networks, such as guidelines developers, communication tools and best practises disseminators are here seen as real grassroots factors of effective action. Still, the lack of training and expertise in local administrations or the cost of plans development can hinder its translation into local coherent climate plans. From the poor climate adaptation advances in adaptation action in both countries we conclude that none of the studied municipalities have followed available guidelines, for example in Spain the integration of mitigation and adaptation plan development has been encouraged (RECC, 2011a). This is also evidenced by the fact that, the signature of CoM rather than joining to RECC has been deterministic for the development of Spanish and Italian mitigation plans (see Table A1 and A2 in the Annex, respectively) conclusion also raised in the climate governance multilevel-assessment developed by the authors in De Gregorio Hurtado et al. (2014).

Our analysis of urban climate action revealed substantial differences in the two countries with Italian cities being more active on average. In Italy, there are slightly more CoM cities with high CO_2e emissions reduction targets and substantially more approved and published local mitigation and mitigation-relevant plans (proportionately and in total). In general, local mitigation efforts in Italy started much earlier than in Spain (1997 in Italy versus 2005[14] in Spain), and more cities in Italy (22%) than in Spain (15%) have local CO_2e emissions reduction targets above 20%. There are very few CCA or CCAR plans, although large parts of both countries are highly vulnerable.

All in all, 75% of the Italian cities and almost 77% of the Spanish cities have approved CCM or CCMR plans or at least there is an official commitment to develop it. Only 11 Italian cities and 7 Spanish cities have CCA or CCAR plans.

From the four sectors most suffering the impacts of climate change identified in Rosenzweig et al. (2011) (local energy system; water supply, demand, and wastewater treatment; transportation; and public health) Italian and Spanish cities largely address the local energy system and transportation in mitigation plans, and although health and water management is addressed in adaptation plans, they are not as generally covered as the first two. This is consistent with a more general finding in recent literature that mitigation implementation success is higher than adaptation, possibly due to a higher public awareness on emissions saving and air pollution health impacts

[14] In Table A1 and A2 we have listed the latest available plans. In Table A1 the earliest Spanish mitigation plan dates from 2008. Nevertheless, Sevilla had a previous plan approved in 2005 (*Estrategia local ante el cambio climático de la ciudad de Sevilla*) and also the city of Vitoria-Gasteiz approved in 2006 the "Estrategia de Vitoria-Gasteiz para la Prevención del Cambio Climático 2006-2012" both related to mitigation. This means that climate action started in practice in 2005.

(Bulkeley et al. 2010), and to the fact that local policy discourses on the importance of mitigation are older than those for adaptation (Kern and Alber 2008). A third reason is that mitigation actions are more directly related to cost-savings, and thus, more easily rewarded. This help policy-makers to be more confident with investments made in mitigation strategies (Olazabal and Pascual 2013). Lastly, low competences in certain sectors (retained at upper levels), such as for example agriculture in Spain or water management in Italy, might be the reason why these sectors are poorly addressed in any of these plans compared to urban planning and design, being this latter of municipal responsibility. This denotes a deeply engrained business as usual approach and the triumph of economic interests (public and private) related to this urban policy.

In addition to these general reasons, we argue that the limited sample of adaptation plans found in both countries may have to do with the limited level of understanding, know-how and technical knowledge on adaptation to climate change which cities may have available for their specific social, economic, and physical contexts (e.g. the particular conditions and behaviour of their local climate), and the difficulty of translating best adaptation practices from one city to another without important investments. Often, local authorities lack the training, the expertise or the funds needed to develop or understand climate information and the know-how to translate it into adaptation measures (Amundsen et al. 2010). This expertise is costly and in light of the uncertainty of climate scenarios is perceived as unnecessary. Cities in Italy and Spain are evidently not willing to invest in adaptation (yet) and the scarcity of EU initiatives for local adaptation and its absence in the policy agenda until the recently published EU Adaptation strategy (EC 2013b) is, we believe, a determining factor. To support these conclusions further research is needed, in addition to the review of planning instruments conducted in this study. In particular, such research efforts should focus on: (i) analysing the actual use of information during the process of plan building ii)) analysing of the level of engagement and commitment of different groups of stakeholders in the development of local climate actions.

6. Conclusions

Responding to climate change in cities is a complex issue. Apart from reacting to the direct impacts of climate change, spontaneous and planned responses are due to many other non-climate related factors such as socio-economic processes, land use or land cover change, technology evolution, social behavioural change, which influence directly or indirectly other sectors and climate variables (Parry et al. 2007).

Our study has revealed a different level of engagement of cities in Italy and Spain. Italian cities are more proactive than their Spanish counterparts. In Italy, there are slightly more CoM cities with high CO_2 emissions reduction targets and substantially more approved and published local mitigation plans. In general, local mitigation efforts in Italy started much earlier than in Spain, and more cities in Italy than in Spain have local CO_2 emissions reduction targets above 20%. In contrast, Spain has a national climate framework in place, but fewer cities with ambitious or pro-active climate plans. Adaptation is not of big concern yet; there are very few adaptation and adaptation-relevant plans in both countries, although large parts of them are highly vulnerable according to ESPON-Climate project (2011). We, thus, concur with existing literature by showing that mitigation actions are more advanced than adaptation actions in these two countries.

We also conclude that international and national networking initiatives are being instrumental in generating urban climate leaders in Italy and Spain. In both countries the networks of cities, particularly the CoM, have played a pivotal role in enhancing cities' climate action and, as De

Gregorio Hurtado et al. (2014) show, have counteracted the lack or the limitations of support of the national governments.

Taken into account the low level of adaptation planning in these two countries, we join the call of the EU Adaptation Strategy and concur with the latest report of ICLEI and CEPS (2002) in that further efforts in engaging cities in adaptation through networks such as CoM is needed. In view of our results, we believe that this would significantly increase the number of plans and also help to transfer the knowledge to local authorities in how best address adaptation efficiently. In this regard, monitoring of the influence of the CoM in the development of adaptation plans in the next few years would be crucial.

Yet, urban climate experiments and governance is increasingly initiated not only by local authorities but also by a wider range of actors and processes, particularly by social movements such as the Transition Towns initiative that started in the UK (Bulkeley and Betsill 2013) or public-private partnerships (Castán Broto and Bulkeley 2013). These new forms of urban climate governance need to be considered in our understanding of the potential of cities.

Acknowledgments

This study has been developed complementary to a larger research work published by the authors in De Gregorio Hurtado et al. (2014), and its results and conclusions feed into it. The whole research project stems from previous work that addressed the analysis of urban leadership in climate change responses in 11 EU countries (Reckien et al. 2014) by analysing cities included in the Urban Audit indicators and by compilation information about plans and action related to climate change, which for this research have been updated and extended (see Sect. 2 Data and Method) looking specifically to Italian and Spanish contexts.

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Authors’ contributions

M.O developed the data analysis and led manuscript preparation. M.O. and S. De G.H. jointly coordinated the study and the edition tasks. DR was the initiator of the European database. M.O., S. De G.H., E.O., M.S., F.P., D.G. V. d’A. E.F. and D.R. contributed towards data acquisition and analysis. Figures and Tables were produced by M.O, S. De G. H., M.S. and E.O. All authors contributed to manuscript edition.

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Appendix A

Table A1: Spanish UA cities used in this study. The table includes information on the mitigation and adaptation and mitigation and adaptation relevant-plans analysed as of January 2013.

City	Pop. (INE, 2011)	Mitigation Strategy / Plan	CCM / CCMR	Year	Adaptation Strategy / Plan	CCA / CCAR	Year
Alicante/Alacant	329,325	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Badajoz	151,214	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Barcelona	1,611,013	The energy, climate change and air quality plan of Barcelona 2011-2020 *(Pla d' energia, canvi climàtic i qualitat de l'aire de Barcelona, 2011-2020)*	CCM	2011	Adaptation plan to climate change *(Pla Estratègic d'Adaptació al Canvi Climàtic)*	CCA	n.a.
Bilbao	351,356	Sustainable Energy Action Plan of Bilbao 2020 *(Plan de Acción para la Energía Sostenible de Bilbao 2020)*	CCM	2012	Local action plan for climate change of Bilbao *(Plan Local de Acción contra el Cambio Climático de Bilbao)*	CCA	2010
Córdoba	328,326	Sustainable Energy Action Plan. Cordoba Municipallity *(Plan de Acción para la Energía Sostenible. Municipio de Córdoba)*	CCM	2010	n.a.	n.a.	n.a.
Coruña, A	245,053	Strategy on Climate Change of A Coruña *(Estrategia contra el Cambio Climático de A Coruña)*	CCM	n.a.	n.a.	n.a.	n.a.
Gijón	276,969	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Las Palmas	381,271	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
L'Hospitalet de Llobregat	256,509	Sustainable Energy Action Plan. *(Pla d'Acci'o per l'Energia Sostenible)*	CCM	2010	n.a.	n.a.	n.a.
Logroño	152,698	Local action plan for climate change *(Plan Local para la lucha contra el cambio climático)*	CCM	n.a.	n.a.	n.a.	n.a.
Madrid	3,198,645	City of Madrid plan for the sustainable use of energy and climate change prevention *(Plan de Uso Sostenible de la Energía y Prevención del Cambio Climático de la Ciudad de Madrid)*	CCM	2008	City of Madrid plan for the sustainable use of energy and climate change prevention *(Plan de Uso Sostenible de la Energía y Prevención del Cambio Climático de la Ciudad de Madrid)*	CCA	2008
Málaga	561,435	Sustainable Energy Action Plan of Malaga *(Plan de Acción para la Energía Sostenible de Málaga)*	CCM	2010	n.a.	n.a.	n.a.
Murcia	437,667	Strategy on Climate Change of the municipality of Murcia *(Estrategia Local frente al cambio climático del municipio*	CCM	2008	Strategy on Climate Change of the municipality of Murcia *(Estrategia Local frente al cambio*	CCA	2008

		de Murcia)			*climático del municipio de Murcia)*		
Oviedo	225,005	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Palma de Mallorca	402,044	n.a.	CCM	n.a.	n.a.	n.a.	n.a.
Pamplona/Iruña	195,943	Sustainable Energy Action Plan of Pamplona (*Plan de Acción para la Energía Sostenible de Pamplona)*	CCM	2011	n.a.	n.a.	n.a.
Santa Cruz de Tenerife	204,476	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Santander	178,095	Sustainable Energy Action Plan *(Plan de Acción para la Energía Sostenible)*	CCM	2010	n.a.	n.a.	n.a.
Santiago de Compostela	95,397	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Sevilla	698,042	Sustainable Energy Action Plan of Sevilla *(Plan de Acción para la Energía Sostenible de Sevilla)*	CCM	2010	n.a.	n.a.	n.a.
Toledo	83,872	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Valencia	792,054	Sustainable Energy Action Plan of Valencia *(Plan de Acción para la Energía Sostenible de la ciudad de Valencia)*	CCM	2010	Sustainable Energy Action Plan of Valencia *(Plan de Acción para la Energía Sostenible de la ciudad de Valencia)*	CCA	2010
Valladolid	311,682	Sustainable Energy Action Plan *(Plan de Acción para la Energía Sostenible)*	CCM	2012	n.a.	n.a.	n.a.
Vigo	295,623	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Vitoria/Gasteiz	240,753	Vitoria-Gasteiz Plan against Climate Change 2010-2020 *(Plan de Lucha Contra el Cambio Climático 2010-2020)*	CCM	2010	Vitoria-Gasteiz Adaptation to Climate Change Plan *(Plan de Adaptación al Cambio Climático de Vitoria-Gasteiz)*	CCA	n.a.
Zaragoza	678,115	Climate change and air quality improvement Strategy *(Estrategia para la mitigación del cambio climático y la mejora de la calidad del aire)*	CCM	2009	Zaragoza climate change adaptation strategy *(Estrategia de adaptacion al cambio climático)*	CCA	2010

Legend:

n.a.	*No information available*
CCM / CCMR	*Climate Change Mitigation / Climate Change Mitigation-Related plan*
CCA / CCAR	*Climate Change Adaptation / Climate Change Adaptation-Related plan*

Table A2: Italian UA cities used in this study. The table includes information on the mitigation and adaptation and mitigation and adaptation relevant-plans analysed as of January 2013.

City	Pop. (2012) (inhab.)	Mitigation Strategy / Plan	CCM / CCMR	Year	Adaptation Strategy / Plan	CCA / CCAR	Year
Ancona	100,465	Draft of Environmental Energy Plan *(Bozza di Piano Energetico Ambientale Comunale)*	**CCM**	2008			
Bari	315,408	Sustainable Energy Action Plan *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	2011			
Bologna	371,151	Sustainable Energy Action Plan *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	2012			
Brescia	189,085	Energy Local Plan *(Piano Energetico Comunale)*	**CCMR**	2002			
Cagliari	149,343	Programme for the Promotion of Solar Energy *(Programma per la promozione dell'Energia Solare)*	**CCMR**	2007			
Campobasso	48,675	Sustainable Energy Action Plan *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	n.a.			
Caserta	75,625	n.a.		n.a.			
Catania	293,104	n.a.		n.a.	Heatwaves Plan for Catania 2011 (Piano rischio ondate di calore 2011) Hydraulics and Hydrology Risk Plan (Piano Rischio Idraulico e Idrogeologico)	**CCAR** **CCAR**	every summer from 2004 2009
Catanzaro	89,319	n.a.		n.a.			
Cremona	69,675	n.a.		n.a.			
Firenze	357,318	Sustainable Energy Action Plan *(Piano di Azione per l'Energia Sostenibile del Comune di Firenze)*	**CCM**	2011			
Foggia	147,045	Municipal Energy Plan *(Piano Energetico Comunale)*	**CCMR**	2007			
Genova	584,644	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*	**CCM**	2010			
L'Aquila	66,905	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*	**CCM**	2011			
Milano	1,240,173	Sustainable Energy and Climate Action Plan *(Piano d'Azione per l'energia sostenibile e il clima)*	**CCM**	2009	Municipality of Milan - Anti-heat Plan (Piano Anticaldo)	**CCAR**	every summer from 2006

Modena	179,095	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*	**CCM**	2011	Sustainable Energy Action Plan (Piano d'Azione per l'energia sostenibile)	**CCAR**	2011
Napoli	961,106	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*	**CCM**	2012	Municipality of Naples - Environment, public health, animals protection	**CCAR**	2007
Padova	205,631	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*	**CCM**	2011	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*[15]	**CCA**	2011
Palermo	656,829	Municipal Energy Plan *(Piano Energetico Comunale)*	**CCMR**	2000			
Perugia	162,097	Municipal Energy-Environmental Plan *(Piano Energetico Ambientale Comunale)*	**CCMR**	2005	Emergency Heatwaves Plan (Piano emergenza calore) Plan for Hydrogeological Risk (Piano rischio Idrogeologico)	**CCAR** **CCAR**	2012 2011
Pescara	116,846	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*	**CCM**	2012			
Potenza	66,698	Sustainable Energy Action Plan *(Piano d'Azione per l'energia sostenibile)*	**CCM**	1997	Heat Emergency (Emergenza Caldo)	**CCAR**	every summer from 2009
Reggio di Calabria	180,719	n.a.		n.a.			
Roma	2,614,263	Sustainable Energy Action Plan *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	2011	Action Plan for Kyoto (Piano d'azione per Kyoto)	**CCAR**	2004-2008
Salerno	132,741	Sustainable Energy Action Plan *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	2012	Sustainable Energy Action Plan (Piano d'Azione per l'Energia Sostenibile)	**CCAR**	2012
Sassari	123,624	n.a.		n.a.	Energy Environmental Regulations and Guidelines for Green Building (Regolamento Energetico-Ambientale e Linee Guida per la Bioarchitettura)	**CCAR**	2008
Taranto	199,936	n.a.		n.a.			
Torino	371,151	Turin Action Plan for Energy *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	2010			
Trento	114,063	Environmental Energy Plan "Trento per Kyoto" *(Piano Energetico Ambientale del Comune di Trento)*	**CCMR**	2007			
Trieste	201,814	n.a.		n.a.			

[15] It is reported a "Climate Plan *(Piano del Clima)*" considering that the first five chapters of the SEAP are focusing on mitigation whereas the 6th Chapter is about "Adapting to a changing climate" and Padova's administration committed also to make its city resilient adhering to the international campaign "making cities Resilient".

Venezia	260,856	Sustainable Energy Action Plan *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	2012	Local Energy Plan (Piano Energetico Comunale - Schede d'azione)	**CCR**	2009
Verona	251,842	Sustainable Energy Action Plan *(Piano d'Azione per l'Energia Sostenibile)*	**CCM**	2012	Sustainable Energy Action Plan (Piano d'Azione per l'Energia Sostenibile)	**CCR**	2012

Legend:

n.a.	*No information available*
CCM / CCMR	*Climate Change Mitigation / Climate Change Mitigation-Related plan*
CCA / CCAR	*Climate Change Adaptation / Climate Change Adaptation-Related plan*

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