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Urban Strategies for Mitigation or Adaptation to Climate Change: What Criteria for Choice?

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Strategies to combat climate change may be based on mitigation of the phenomenon or on adaptation to its consequences. This paper aims to identify the driving factors of the choice between these two categories of strategies in the context of urban climate plans. The fight against climate change being characterized by a logic of free riding, the situation tilts the balance towards adaptation strategies in an urban context, to the detriment of mitigation. This hypothesis is tested here through a review of the existing literature on urban climate strategies. This study shows that, counterintuitively, mitigation prevails over adaptation in urban climate strategies up to now. This paper explores the explanations for this seemingly paradoxical situation. We argue that a big part of the explanation has to do with the institutional context of urban climate strategies, specifically the decision-making capacities of municipalities, or the fact that they take part in international networks promoting mitigation over adaptation. Other explanations rely on the cost/benefit impact of adopting mitigation or adaptation, like the collateral local/private benefits of urban climate strategies that are often bigger with mitigation than adaptation. Another finding is that there is no systematic planning making it compulsory to choose between mitigation and adaptation strategies, as they are in some instances complementary, providing co-benefits.

Keywords: Climate change; mitigation; adaptation; urban strategies; co-benefits.

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1. Introduction

Climate risk management involves a balance between three types of costs: Damage costs, costs of adapting to the impacts of climate change, and costs of mitigating these impacts. These costs are of course not mutually exclusive, and the climate trajectory that the world will follow will be made up of a combination of these three types of costs. However, it is

inevitable that the resources devoted to covering one of these types of costs cannot be directed towards another simultaneously. These unavoidable trade-offs have decisive consequences for the formulation of climate policies, which can be grasped by imagining the extreme scenarios accompanying the trade-offs in question. If, for example, no resources are invested in mitigating or adapting to climate risks, the consequences will most certainly be devastating to the point of destroying a large part of the wealth accumulated thanks to the resources diverted from climate policies. If all efforts are devoted to mitigation, the impacts of climate change will be reduced, but will still probably be sufficient to disrupt human communities that have not been prepared for these impacts through adaptation efforts. Finally, if adaptation takes up all the resources devoted to climate policies, the impacts of climate change are likely to overwhelm some adaptive capacity in many parts of the world in the long term.[1] These trade-offs are inevitable, and it is crucial to understand how they are made at different levels of individual or collective decision-making. A key element of these trade-offs lies in the nature of the benefits that climate change mitigation and adaptation strategies generate. Mitigation generates mostly (but not exclusively) global collective benefits, in the sense that whatever scale these strategies are designed (individuals, firms, nations. . .) at, their effects spread globally. This is due to the natural phenomenon of global warming, created by uniformly mixed pollutants emitted into the atmosphere at the planetary scale, whose mitigation has the reverse effect. Adaptation generates mostly "private" benefits that go directly to the actors making these efforts to adapt to climate change. This should theoretically result in a free riding effect whereby, left to their own devices, the actors turn more spontaneously towards adaptation efforts rather than mitigation, insofar as the cost-benefit ratio is systematically more favorable in this case. If this were to be confirmed, climate strategies would be faced with a major problem regarding how actors adopting them can be incentivized to actively participate in mitigation efforts, making it even more difficult than it is already the case to achieve the ambitious objective set by the Paris Agreement to limit global warming to a maximum of 2°C.

This hypothesis is to be tested in the case of urban climate strategies, which constitute a sort of intermediate stage between the individual decision-making level and the state level at which national strategies are designed. Based on a literature review of existing studies on these urban climate strategies, we will see whether cities that adopt this type of strategy are leaning towards mitigation or adaptation to climate change and try to understand why.

Our main objective here is thus to understand how and why cities engage in climate mitigation or adaptation strategies. This requires us to map these strategies and identify the driving forces, in order to verify whether the assumption that adaptation prevails over mitigation as one moves to a more local/city level of observation is true. Studies of urban climate strategies have been multiplying over the past decade. These studies focus mainly on North American and European cities, which are pioneers in this field because of their financial and economic capacities to engage in this process. There are, however, important initiatives in cities of developing countries, such as in Quito

[1] According to Downing (2012), adaptation might offset 75% of mild climate impacts, but only 10% of severe impacts.

(Zambrano-Barragán *et al.*, 2011) or Durban (Roberts, 2010), which can contribute to assess the adaptation/mitigation balance. Most studies have focused on identifying the drivers of mitigation and adaptation (Reckien *et al.*, 2015; Aylett, 2014), but none of them addresses the question of why the distribution between these two strategies tilts towards mitigation or adaptation at the local/city level. Our aim is to provide the explanations behind the observed trends, in order to understand why cities tend to prioritize strategies to mitigate or to adapt to climate change.

This paper is organized as follows. Section 2 sets the theoretical framework. Section 3 assesses the structure of incentives to adopt one or more of these strategies at different scales of decision-making, from the individual to the global level. Section 4 reviews urban climate strategies as observed in existing studies, to have a clear understanding of the distribution between mitigation and adaptation strategies at the city level. Section 5 attempts to interpret the reasons for this observed distribution, which in fact is not as unfavorable to mitigation strategies as the above-mentioned free riding effect would suggest. Section 6 draws conclusions.

2. Theoretical Foundation and Research Method

The research questions addressed in this study are the following: How are climate mitigation and adaptation strategies distributed at the urban level? How can we explain this observed distribution? Is this distribution supporting the hypothesis based on the collective action theory according to which adaptation, bringing mostly local/"private" benefits in urban climate action plans, should prevail over mitigation, which brings planetary/collective benefits?

The research method is based on a systematic review of the existing literature on urban climate strategies and action plans. We investigated and categorized the driving factors behind the adoption of either mitigation or adaptation plans at the city level, in order to identify which of them would support the hypothesis of a bias in favor of adaptation plans.

Having found that there is no such bias, we completed this study of urban climate change strategies by an investigation of the extent to which mitigation and adaptation plans can be considered as conflicting or complementary.

3. Mitigation or Adaptation to Climate Change: The Logic of Incentives at Different Decision Scales

On a strict individual level, it is obvious that in the case of climate change, the actors are facing the most insurmountable free riding problem. Each individual wishing to contribute to the fight against global warming must bear the costs of his/her involvement without reaping any benefits in terms of climate mitigation (these efforts contributing up to the ratio of 1/world population to the global mitigation effort[2]). Only a personal conviction that

[2] If we do not take into account the fact that per capita levels of emissions are vastly different from one country to the other.

disregards these cost/benefit ratio considerations can motivate an individual to make these efforts, unless there are some non-climate related benefits associated to this behavior, which is the case in some circumstances.[3] Since this type of conviction is not widespread, we should observe behaviors at the individual level that are more inclined towards adaptation to climate impacts, at least for those individuals whose perception of the problem leads them to react. Adaptation provides short-term private benefits that can compensate for the efforts made. However, observing individual behaviors in this area is not easy. Research has only recently begun to address these issues. Demski *et al.* (2017) propose, for example, to explore how extreme climatic events that occurred in the United Kingdom in the winter of 2013–2014 contribute to eliciting reactions from impacted individuals in terms of perception and intention to adapt to the impacts. This study deals just with intentions to act, and we often see that individuals adopt measures when they see an immediate economic return. But this confirms that incentives lead more spontaneously to adaptation. It is of course possible that individual adaptation strategies may have impacts in terms of mitigation as well (see e.g. Bryan *et al.*, 2013; Duguma *et al.*, 2014), but this is not due to intentional effects. Siña *et al.* (2016) explores the individual perceptions of climate risks of representatives of five municipalities in Lima, Peru. Their results reveal a very low awareness of these risks, and a strong concern for issues that, if linked to climate strategies, would be in line with adaptation rather than mitigation capacities, such as access to water treatment services. Howell *et al.* (2016) find from a study of 800 British individuals that people who are aware of climate issues are more likely to support mitigation measures, whereas people without such awareness would be more likely to be convinced to make adaptation efforts.

Recently conducted behavioral studies on individual intentions to contribute to climate strategies therefore reveal a clear bias in favor of adaptation. The literature is more consistent in the agricultural field, in which individual behaviors in the face of observed or expected climate change impacts are observed in most cases. Studies carried out in the agricultural sector confirm that individual behavior tends to be more spontaneously oriented towards adaptation (Arbuckle *et al.*, 2013). An OECD study (2012) concludes that mitigation behaviors in the agricultural sector are mainly the result of exogenous incentives, whereas adaptation behaviors are more based on endogenous stimuli such as the risk of loss of income. Bryan *et al.* (2013) note that farmers in Kenya are adapting to the perceived impacts of climate change mainly by changing crop varieties or changing planting dates. Jørgensen and Termansen (2016) note that most Danish farmers are already adapting to the impacts of climate change, while mitigation is not one of their major concerns.

Klein *et al.* (2007) confirm that mitigation generates global benefits spread over the long term, whereas adaptation generates local benefits in the short term. As a result, mitigation strategies are mainly the result of international agreements and their implementation within the framework of national policies, whereas adaptation strategies are

[3] Energy saving measures contribute to mitigating climate change while bringing individual financial benefits.

motivated above all by the interests of private actors or communities affected by climate change.

At the global scale of nations, incentives take a radically different form, as actors may coordinate their actions at this scale to achieve tangible mitigation results, since they have the capacity of coalition. This obviously does not entirely eliminate the problems of free riding, but negotiations between the actors are precisely aimed at getting around this difficulty in order to reach a global mitigation target while creating a climate club (Nordhaus, 2015). The Paris Agreement, adopted in 2015, is thus based on a bottom-up approach, whereby each country is led to propose its national contribution to the global effort. This more easily encourages the largest greenhouse gas (GHG) emitters to participate in the collective effort through mitigation strategies. The goal has been achieved, in the sense that the Agreement has been ratified by several countries (in 2016) to enter into force. However, its effects have so far fallen short of the main target, a maximum global warming of 2°C. The intended nationally determined contributions are insufficient, and for the moment put the planet on a warming trajectory of around 2.7°C minimum according to the Climate Action Tracker.[4] In any case, such an agreement is mainly aimed at mitigation efforts.

This does not preclude the possibility of orienting strategies towards adaptation if the actors see the need for it. In fact, over the last two decades, there has been a trend whereby, as the costs of climate impacts become increasingly evident (mainly through extreme weather events), and as mitigation loses ground (due to a lack of commitment from governments and private actors), adaptation becomes an increasingly important component of these strategies, as the impacts of global warming appear unavoidable. Adaptation is now a priority for the actors most affected by the asymmetry between the low historical responsibility for climate change (in terms of past GHG emissions) and the intensity of the long-term impacts of the phenomenon: Mainly developing countries, which are demanding the right not to participate massively in mitigation while benefiting from external aid in order to increase their capacity to protect themselves against the effects of global warming. International negotiations have thus evolved towards a better consideration of their needs. This led in 2010 to an agreement on the creation of an international fund (the Green Climate Fund, operational since 2015) whose aim is to provide equal support for climate change mitigation and adaptation efforts in emerging and developing countries, and to direct at least 50% of adaptation efforts towards the most vulnerable countries. The agreement was supposed to provide for the transfer of $100 billion annually from rich countries to the countries concerned from 2020 onwards, but has failed to reach this target up to now.

Adaptation and mitigation are therefore an integral part of the strategies adopted by public actors at national and international levels, as they are not subject to the behavioral biases in favor of adaptation observed at the sub-national levels. Nevertheless, it seems that mitigation remains the preferred strategy of public actors: Richmond *et al.* (2020) estimate that in 2017–2018, $30 billion of public funds were invested worldwide in climate change

[4] https://climateactiontracker.org/global/cat-thermometer/ (accessed April 7, 2023).

adaptation, compared to $537 billion for mitigation. Even though other estimates by the Global Commission on Adaptation (2019) show an extremely favorable ratio between the adaptation investments required between 2020 and 2030 ($1,800 billion) and the net long term benefits ($7,100 billion). Nations remain firmly committed to the goal of climate change mitigation.

What about the actors situated at an intermediate level between the individual and the global, who constitute a kind of collective entity driven by a variable geometry combination of individual and common interests?

In the case of firms, the answer seems clear: They adopt measures to mitigate or adapt to climate risks when they are in line with their overall profit optimization strategy, or when they are obliged to do so by law (Cömert Baechler, 2016). In terms of profit optimization, the driving forces can be on the demand side (consumption trends oriented towards environmental protection, firms' reputation risks) or on the supply side (opportunities for cost reduction).

Cities offer a more complex field of analysis for climate strategies. They are not driven primarily by market constraints like firms, and make collective decisions guided by both local governance requirements and constraints imposed by the state level of political representation. Nor do they have the capacity for autonomous decision-making on climate strategy in the same way that nations can negotiate mitigation targets among themselves, due to the global nature of the phenomenon, which prevents any efficient global coalition among cities. They are, however, key players in climate strategies, since they represent both major sources of GHG emissions and areas of major impact of global warming, in other words, decisive opportunities in terms of mitigation and adaptation to climate change. Table 1 provides a list of both mitigation and adaptation strategies that can be adopted at the urban level.

Table 1. Potential mitigation or adaptation strategies at the urban level.

Type of strategy	Sector	Implementable scheme
Mitigation	Urban infrastructure	Alternative low-carbon energy supply.
		Landfill gas capture.
		Waste collection for recycling and reuse.
		Energy and water conservation measures.
	Built environment	Use of energy-efficient materials.
		Energy-efficient designs.
		Building-integrated alternative energy supply.
		Energy-efficient technologies in new buildings.
		Retrofitting energy-efficient technologies.
		Energy-efficient appliances.
	Transport	Low-carbon infrastructure renewal.
		New low-carbon infrastructure.
		Transition to low or zero emission vehicles.
		Fuel-switching.
		Energy efficiency enhancing.
		Mobility demand reduction schemes.
		Alternative mobility demand enhancing measures.

Table 1. (*Continued*)

Type of strategy	Sector	Implementable scheme
	Carbon sequestration	Urban capture and storage. Urban tree-planting programs. Restoration of carbon sinks. Conservation of carbon sinks. Carbon offset schemes.
Adaptation	Urban infrastructure	Cooling services and design. Measures securing energy and water supply. Flood protection. Wildfire protection. Blue and green infrastructure.
	Urban planning	Relocation and zoning policies. Early warning systems. Building codes for extreme weather.
	Behavior-based measures	Price or subsidy schemes. Insurance or liability schemes.

Source: Made by the author.

4. Urban Climate Strategies: An Overview

Cities are currently home to 55% of the world's population, a total that is expected to increase to 68% by 2050, mainly as a result of rural–urban migration in developing countries, as the urban population in Africa and Asia is expected to increase by 2.5 billion people over the next 30 years. They account for two-thirds of global energy consumption and nearly 70% of global GHG emissions (UN Habitat, 2019). The observed differences in per capita emissions are similar to those at the national level, with levels of around 2 tons per person per year in most developing countries, 30 tons in the largest cities in the US, and intermediate levels in Europe. Cities thus contain a considerable reservoir of climate change mitigation capacity, with significant differences between countries at different levels of development. In rich countries, the options are mainly in terms of urban planning, energy rehabilitation/conversion of buildings and reform of transport modes, while in developing countries, the focus is on planning for infrastructure that is being deployed because of rapid urbanization. In all cases, the opportunities arise in the following forms: Energy savings and improved energy efficiency of urban services and buildings, decarbonization of electricity supply and transport, improved waste management, urban planning geared towards housing densification.

Because of the very high concentration of inhabitants, physical assets, and economic activities that they represent, cities are also at the forefront of vulnerability to climate impacts. About 90% of them are located in coastal areas; 710 million people currently live in coastal urban areas less than 10 meters above sea level, representing more than half the population in countries such as the Netherlands, Vietnam, and Thailand (Coalition for Urban Transitions, 2019). Urban populations are therefore particularly exposed to two of the main expected or already observed impacts of climate change: In the long term, sea

level rise which could reach up to 1 meter by the end of the 21st century; in the short term, extreme weather events such as hurricanes, extreme precipitation or extreme temperatures. In 2022, 823 cities reported 2,075 high-risk hazards to the Global Covenant of Mayors (GCoM), the world's largest alliance for city climate leadership across 144 countries (GCoM, 2022). Cities are therefore also a key component of adaptation strategies that are increasingly needed on a global scale. In this regard, the opportunities to be seized are in the form of protection infrastructures against the impacts of global warming (rising sea levels, floods. . .), management of access to water, urban development to reduce the effects of global warming on populations (the heat island effect for example), and health management of the impacts (Revi *et al.*, 2014).

Our main objective here is to understand how and why cities engage in climate mitigation or adaptation strategies. This requires us to map these strategies and identify the forces driving them, in order to verify whether the assumption that adaptation prevails over mitigation as one moves to a more local level of observation is true. Studies of urban climate strategies have been multiplying over the past decade. Some studies have focused on identifying the drivers of mitigation and adaptation (Reckien *et al.*, 2015; Aylett, 2015), but none of them addresses the question of how the distribution between mitigation and adaptation can be explained. These studies focus mainly on North American and European cities, which are pioneers in this field because of their financial and economic capacities to engage in this process. There are, however, important initiatives in cities of developing countries, such as in Quito (Zambrano-Barragán *et al.*, 2011) or Durban (Roberts, 2010).

The study proposed by Reckien *et al.* (2018) covers 885 cities in the 28 countries of the European Union (before Brexit). Of the 28 member countries, 24 do not require local climate plans (LCPs). Only Denmark, France, Slovakia, and the United Kingdom require such plans from municipalities (with more than 50,000 inhabitants, except in France where the threshold is set at 20,000). Denmark is the only country where adaptation plans alone are required locally by law. But mitigation plans are indirectly made mandatory through municipal plans for the reduction of fossil fuel-dependent district heating. In fact, Denmark is the only one among the 28 EU countries where 100% of the cities have a mitigation or adaptation plan. Elsewhere, regardless of the status of these local plans (mandatory or not), mitigation prevails over adaptation, by nearly 64% against 56% in countries where these plans are mandatory, and 37% against 11% in countries where they are not. The adoption of any plan is generally linked to the size of the agglomeration, which is of course explained by the economic and financial means provided by human density.

Grafakos *et al.* (2020) use the same sample of European cities to test the degree of integration of mitigation and adaptation plans that can create synergies between the two types of strategies. They note that 147 out of the 885 cities envisage this integration, but that among them 75% have adopted a target for reducing their GHG emissions (a mitigation target), while 57% jointly consider an emissions reduction and an adaptation plan.

Heidrich *et al.* (2016) find the same trends in a (different) sample of 200 European cities, of which 64% have a mitigation plan and 23% an adaptation strategy. Heidrich *et al.* (2013), covering 30 UK cities, confirm this prevalence of mitigation over adaptation.

Table 2. Distribution of climate mitigation and adaptation strategies at the urban level.

Reference	Sample of cities covered	Mitigation plan only	Adaptation plan only	Mitigation and adaptation plan combined
Aylett (2014)	264 US and European cities	24%	3%	73%
GCoM (2022)	12,613 cities around the world	77%	18%	N/A
Heidrich *et al.* (2013)	30 UK cities	94%	69%	54%
Pietrapertosa (2019)	76 Italian cities	74%	0%	0%
Reckien *et al.* (2015)	200 European cities	65%	28%	25%
Reckien *et al.* (2018)	885 cities in EU 28	66%	26%	17%

Source: Made by the author.

Pietrapertosa *et al.* (2019) find that most Italian cities pay great attention to climate change but have a tendency to adopt mitigation plans much more than adaptation ones.

Zimmerman and Faris (2011) note a systematic weakness of adaptation plans compared to mitigation efforts in North American cities at the end of the 2000s. A study by Aylett (2014) of 700 member cities of the ICLEI (Local Governments for Sustainability) network, and in fact concerning mainly American cities, reveals that 58% of them jointly adopt mitigation and adaptation plans, but that 41% have only mitigation plans.

The same trend emerges from the latest annual report of the GCoM (2022), an international coalition of municipalities designed to share experiences and encourage local dynamics in the fight against climate change. Among the cities reporting their experiences in this field, the majority of plans currently designed or implemented focus on mitigation. As a result, nearly 9,500 urban areas on all continents, representing more than 10% of the world's population, have adopted a target for reducing their GHG emissions.

The emerging trend is therefore clear: Climate change mitigation strategies outweigh those for adapting to its impacts at the urban level. Table 2 provides an overview of the distribution between climate mitigation and adaptation strategies at an urban level according to the (few) existing studies covering a large spectrum of cities.

Intuitive reasoning based on the logic of incentives at work, however, would have led one to believe that adaptation provides a more advantageous cost/benefit ratio at a local level such as the city level. Further reasoning is therefore required to understand what motivates urban areas to adopt either strategy.

5. Attempted Explanations for the Choice of Urban Climate Strategies

A first explanation to the prevalence of mitigation strategies over adaptation strategies at the urban level would be that cities are obliged to adopt them by instruction of national authorities, themselves committed by international treaties to mitigation efforts. However, this explanation does not stand up to scrutiny. We noted earlier (Reckien *et al.*, 2018) that in the EU, mitigation prevails over adaptation at the urban level even in countries where local plans are not made mandatory by national authorities.

Another plausible explanation would be that cities are increasingly involved in international networks promoting climate strategies, and that at this level, the priority remains

mitigation to limit global warming, in line with the international negotiations that led to the conventions and treaties dealing with climate issues. These networks have multiplied over the last two decades, both at the global and regional levels. This "governance from above" would therefore tend to tilt local climate plans towards mitigation, to the detriment of adaptation. Grafakos *et al.* (2020) thus note that European cities have started to consider climate change mitigation in their local plans thanks to the support of the GCoM network. Reckien *et al.* (2018) also note that among European cities that are part of such international networks, mitigation plans outweigh adaptation. Heidrich *et al.* (2016) find that the proactive role of cities in climate change is in most cases linked to their involvement in international coalitions or EU projects. The EU is indeed a key driver of urban strategies through a multiplication of initiatives helping member countries to intensify the participation of local actors: the 2020 Energy Strategy (European Commission Directorate General for Energy, 2010), the GCoM (launched in 2014 by the European Commission), the Smart Cities Initiative. At the global level, we find the International Council for Local Ecological Initiatives (ICLEI, created in 1993) and the Cities for Climate Protection Campaign (CCPC), two initiatives under the impetus of the United Nations Environment Programme (UNEP) which currently cover more than 25% of the world's urban population, as well as the C40 Cities Climate Leadership Group, created in 2005 at the initiative of the Mayor of London, and which today brings together nearly 100 of the world's largest cities. These global or regional initiatives do not systematically neglect urban adaptation efforts, but were mostly created at a time when mitigation was still the top priority, to the detriment of adaptation (Bassett and Shandas, 2010). A rebalancing has recently begun, notably with the GCoM at the global or European level.

The pre-eminence of mitigation over adaptation at the urban level is probably also due to local governance capacities. Indeed, local authorities in charge of cities have a significant governance capacity in key sectors of climate risk management, such as transport, housing, waste management, energy supply or water management, all of which are much more directly linked to mitigation efforts than to adaptation efforts (Reckien *et al.*, 2014). Furthermore, mitigation strategies typically rely on measures applied to specific urban sectors or functions (efficiency of heating systems, urban mobility management, building insulation, and so forth), while adaptation generally involves systemic changes on a broader scale (zoning or urban planning, infrastructure to protect against extreme weather events, and so forth). As a result, adaptation plans often need to be designed on a larger scale than the city, as in the case of the Netherlands, where adaptation to sea level rise is managed exclusively at the national level (Reckien *et al.*, 2018).

A recent study thus estimates that mayors have the capacity to make decisions or influence a range of measures representing 28% of global climate change mitigation capacity at the urban scale, compared to 35% for national governments (Coalition for Urban Transitions, 2019). This confirms both the extent of local governance capacity in terms of mitigation, and the need for cooperation between local and national governance to carry out these efforts.

In addition to the previous point, it can also be stressed that mitigation strategies are relatively easier to integrate into urban planning than adaptation strategies, due to their

generic and less information-intensive nature (Reckien *et al.*, 2015). Regardless of the city, measures to reduce GHG emissions are indeed more or less the same from one part of the world to another: They mainly concern the insulation and energy efficiency of buildings, as well as the reduction of energy consumption in transport.[5] Resilience to climate impacts, on the other hand, requires radically different measures when it comes to adapting to, for example, the urban heat island effect or sea level rise in coastal areas. In both cases, the adaptation strategy must be based on a body of local information capable of guiding the design of tailor-made urban plans.

Another decisive factor in explaining that mitigation outweighs adaptation at the urban level is the type of benefits that both strategies provide in this context of decision. We have previously stressed that the benefits of mitigation are collective/global, while those of adaptation are private/local. But what about the co-benefits of either strategy, which would not be directly linked either to mitigation or adaption? If these co-benefits were sufficiently important, they could ensure that the problem of free riding created by the collective nature of the direct benefits from mitigation is overcome by the possibility of reaping additional private/local benefits. This seems to be the case, and much more so for mitigation than for adaptation. The co-benefits of mitigation manifest themselves in terms of improved air quality (insofar as the reduction of GHG emissions contributes jointly to the reduction of emissions of other pollutants), energy savings or progress in public health (Seto *et al.*, 2014). They are difficult to calculate precisely, but some studies provide estimates. One of the most recent and detailed studies (Coalition for Urban Transitions, 2019) identifies a set of decarburization measures, which are technically accessible and would reduce urban GHG emissions by almost 90% by 2050. This would be achieved through an annual investment of around $1,830 billion (2% of 2014 global GDP), and would generate an annual gain of $2,800 billion in 2030 and $6,980 billion in 2050, for a net present value of $2,390 billion. The detailed estimates reveal that the calculated gains are not the environmental benefits of climate change mitigation, but the returns on investments made in different sectors of urban management, dominated by energy efficiency in buildings and urban mobility management, in other words, the private co-benefits of mitigation strategies. According to this study, these benefits are not only high, but potentially exceed initial investments.

It is difficult, however, to identify the same type of co-benefits for climate change adaptation strategies. Urban development plans designed, for example, to cope with sea level rise or increased risk of flooding generate the benefits for which they are designed, but not beyond.

A related point sometimes concerns the conflicting nature of climate change mitigation or adaptation strategies. Adaptation measures can have a negative impact on mitigation capacities in two main ways (Landauer *et al.*, 2019): A more dispersed urban structure, to allow for the expansion of green spaces capable of absorbing atmospheric carbon, would

[5] The building sector's carbon saving potential representing 58% of the total, while the transport sector amounts to 21%, according to estimates by the Coalition for Urban Transitions (2019).

increase the demand for fuel for mobility; adaptation measures can increase energy demand through increased cooling requirements.

Conversely, mitigation measures can have a negative impact on adaptive capacities, such as when urban densification to reduce mobility needs (and associated GHG emissions) leads to an increase in the urban heat island effect, or a decrease in the capacity to manage surface water runoff. In all these cases, it may be thought that the attractiveness of mitigation is enhanced by the fact that it is often not compatible with adaptation: The "best" strategy drives out the other.

A hypothesis that would deserve to be systematically tested, but which goes beyond the scope of this study, concerns the limits of what adaptation strategies can bring in terms of climate risk management, compared to mitigation strategies. The link between the resources (of all kinds) invested in the reduction of GHG emissions and the results obtained in terms of climate change mitigation is in a way continuous: 15% reduction of these emissions contributes more to mitigation than 10%, but less than 20%. The return on investment is proportionate to the effort made (which does not of course prevent the problem of free riding). This is not the case with adaptation, which produces discontinuous, stepwise results. A minimum level of investment is needed to achieve an adequate level of protection against sea level rise in coastal areas, or against the risk of destruction of urban infrastructure by extreme weather events. This inevitable critical mass of adaptation-oriented resources is in itself a barrier that is likely to be difficult to overcome in many cases, in particular in small or middle-sized cities whose financial capacities are insufficient to cover these upfront costs.

The hypothesis is partly confirmed by the observation that cities that adopt adaptation strategies are systematically and significantly larger and richer than those that do not (Araos *et al.*, 2016; Reckien *et al.*, 2015; Shi *et al.*, 2015). Following Hurricane Sandy in 2012, which caused nearly $19 billion in damage, the New York City municipality launched a similarly large investment plan to strengthen the city's capacity to adapt to this type of natural disaster.

Another form of confirmation comes from the fact that large municipalities have the capacity to fund local adaptation plans, while national or international funding sources are crucial for adaptation plans at smaller urban scales or for less densely populated areas (Otto *et al.*, 2021; Aguiar *et al.*, 2018).

A more systematic study of this hypothesis would probably make it possible to identify thresholds for adaptation investment in urban areas likely to generate increasing levels of protection in discontinuous steps. These levels would constitute "zones of adaptability" that would be financially accessible to some municipalities, but not to others without external assistance.

Such a confirmation would make it possible to rule out the hypothesis that the pre-eminence of the mitigation strategies analyzed here stems from a statistical bias that cannot be totally excluded as things stand at present. As a matter of fact, the existing literature on urban climate plans more systematically focuses on large cities located in rich countries, for which it is confirmed that population density and high living standards are accompanied by a much higher carbon footprint than elsewhere (Moran *et al.*, 2018). For these

cities, mitigation measures represent an investment that is both relatively modest in relation to the living standard of their population and attractive in terms of the potential to reduce their carbon footprint. But, once again, this state of affairs should not have a decisive influence on the orientation of urban climate strategies towards mitigation, if the previous hypothesis concerning levels of adaptability could be confirmed.

Finally, it should be noted that the distribution of urban climate strategies between mitigation and adaptation is an evolving process, notably under the impact of the growing awareness of the synergies and co-benefits they entail (Sharifi, 2021; Zhao *et al.*, 2018; Landauer *et al.*, 2015; Hamin and Gurran, 2009). For example, the use of building materials designed to reduce energy consumption and GHG emissions can contribute to better insulation that will provide better interior protection against temperature increases. Planting trees in urban areas can contribute to mitigation by absorbing atmospheric carbon and to adaptation by making rising temperatures more bearable. In cities of developing countries, better water and waste management increases resilience to climate change impacts while reducing emissions from untreated decaying materials (Sugar *et al.*, 2013). However, in all these cases, it becomes difficult to qualify the strategies in question as either mitigation or adaptation, since by definition they include elements of both.

It appears finally that the set of factors influencing the distribution of climate change mitigation and adaptation strategies at the urban scale fall into two distinct categories, which help to understand why mitigation prevails over adaptation. The first concerns the governance capacities of urban development, and the resulting opportunities to develop one or the other of the two strategies at this scale of governance: Membership in international networks of cities emphasizing mitigation, better institutional control of mitigation measures at the urban scale, and greater ease in designing mitigation plans than adaptation plans in urban environments. The second category of factors relates more directly to the impacts of either strategy when applied at the urban scale: They may generate co-benefits or conflicts of objectives, and may also imply continuous or discontinuous impacts in terms of mitigation versus adaptation capacities in the long run. In this second category, it seems that mitigation prevails again over adaptation, but a fundamental conclusion is also that in many instances, both strategies are complementary. Table 3 lists the domains in which mitigation and adaptation are either conflicting or complementary in urban climate action plans.

It seems then crucial to orientate urban climate strategies toward measures prioritizing the co-benefits and synergies between mitigation and adaptation strategies, a way to overcome the bias in favor of mitigation. Out of the 147 EU cities investigated in Reckien *et al.* (2018) having both mitigation and adaptation plans, Grafakos *et al.* (2020) note that only 38 of them consider these co-benefits and synergies in the domains of green urban infrastructures and energy efficiency of buildings. This represents not only a loss of environmental efficiency in dealing with a key threat for the development of urban areas in coming decades, but also a loss of economic resources and efficiency in climate policy making, which could be avoided by framing urban climate action plans in a more systematic way in order to exploit these synergies. There are only few studies investigating these synergies from a theoretical or empirical point of view (Grafakos *et al.*, 2019;

Table 3. Conflicts, trade-offs, co-benefits, and synergies in urban climate action plans.

Conflicts or trade-offs: When an adaptation (or mitigation) action leads to negative mitigation (or adaptation) effects.	Conventional air conditioning aims to reduce the summer heat impact in indoor environments (adaptation: Positive), while it simultaneously increases carbon emissions due to high energy demand (mitigation: Negative). The densification of urban planning helps mitigate carbon emissions from transportation (mitigation: Positive), but increases the urban heat island effect (adaptation: Negative). The densification or urban planning helps mitigate carbon emissions, but increases heat stress and demand for air conditioning, and potentially use of fossil fuels for electricity production (mitigation: Negative). The densification of urban planning helps mitigate carbon emissions, but can hamper the management of surface run-off water, require further investments in urban drainage and reduce land use options for 'soft' engineering measures for adaptation, such as green and blue infrastructure.
Co-benefit or synergies: When an adaptation (or mitigation) action leads to positive mitigation (or adaptation) effects.	Effective building materials can reduce energy use and carbon emissions (mitigation), and lead to better insulation and improved indoor temperature comfort during warmer temperatures (adaptation benefit). Planting trees in urban areas can act as a carbon sink (mitigation), and have an urban cooling effect during hot weather (adaptation benefit). Planting trees in urban areas can act as a carbon sink, and facilitate the management of increased urban runoff water from climate change (adaptation benefit). Green roofs can increase the energy efficiency of buildings (mitigation) while help retain water during storms, contributing to building climate resilience through decentralized water management systems (adaptation benefit). Developing urban sustainable farming practices (adaptation) contributes to lowering the carbon footprint of transporting food products for urban population (mitigation benefit). Promoting urban sustainable farming contributes also to the carbon capture potential through biomass (mitigation benefit). Retrofitting buildings in order to make them more water efficient (adaptation) contributes to reducing energy use to pump, heat and distribute water (mitigation benefit).

Source: Made by the author.

Landauer *et al.*, 2019, 2015; Demuzere *et al.*, 2014). There is an evident need in strengthening our knowledge in this domain, especially in regard to the fact that urban areas will continue to expand in coming decades, particularly in developing countries, giving opportunities to incorporate these synergies in urban climate action plans.

6. Conclusion

Urban climate strategies, as far as they have been studied so far, are still dominated by climate change mitigation efforts. Since this observation is *a priori* not compatible with an initial analysis of the incentives at work to adopt one or other of these strategies at the

urban level, we have had to take this analysis further in order to understand the driving factors at work behind this contradictory observation. Indeed, there are many explanations for the fact that urban climate plans are still biased towards mitigation, as this study demonstrates. However, this does not prevent cities around the world from deciding to gradually reorient their urban strategy in favor of adaptation in the future, particularly in response to the relative failure of national climate policies, which will most certainly have difficulty containing global warming below the 2°C target set out in the Paris Agreement (not to mention the 1.5°C target). The recently released iteration of the IPCC assessment reports (2022) reached a fundamental conclusion that has probably been overlooked: The difference in near-term risk between worlds with better and worse adaptation is greater than between worlds with more or fewer emissions. This means that adaptation measures need to become a growing part of climate strategies, at any level, because adapting to climate change impacts is becoming as crucial as mitigating the phenomenon. Since cities are at the forefront of adaptation capacities for reasons exposed in this paper, the world will increasingly rely on their adaptation strategies to be able to deal with climate change in the best possible conditions. But this should not obscure another crucial finding of this study that climate mitigation and adaptation capacities at urban level can be co-benefits of the same strategies, which should be seen as a potential to overcome the bias those strategies have in favor of mitigation.

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