

CHAPTER 2:

CITIES AND CLIMATE CHANGE: HARNESSING THE POTENTIAL FOR LOCAL ACTION

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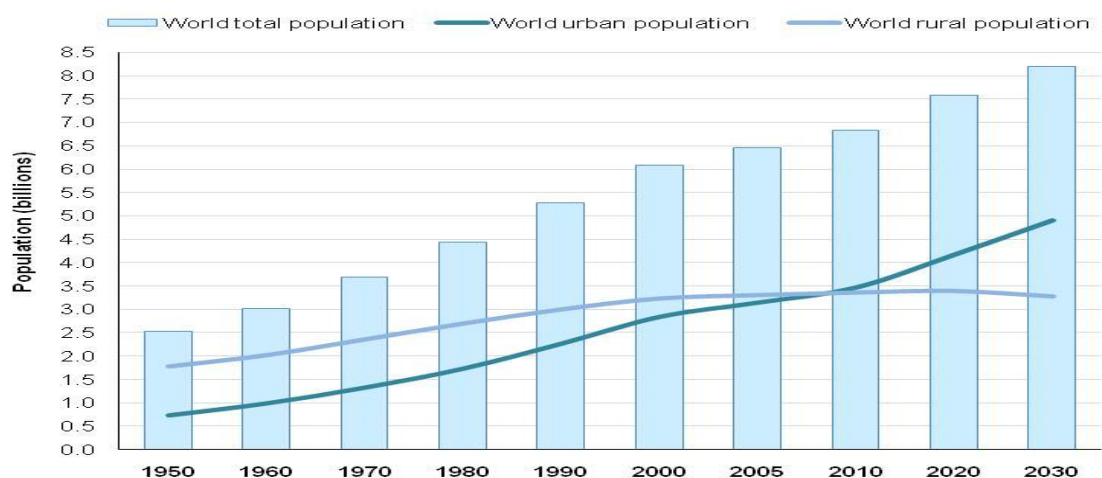
Despite a flurry of activity in cities on climate change and growing interest in the research community, climate policy at city-scale remains fragmented and basic tools to facilitate good decision-making are lacking. The paper highlights two different tools for further development that can be enhanced by strengthened multi-level governmental and public-private partnerships to support city-scale action to address climate change: harmonised inventory preparation and registries for monitoring GHG emissions at city-scale over time; and improved mechanisms for sub-national science-policy exchange to develop, assess and integrate knowledge about climate change impacts into urban policy and decision-making. While the agenda for multi-level governance of climate change is inevitably much broader than this, first steps by national governments to work with sub-national governments, cities and experts to advance capacity and tools in these two areas could be important first steps to move the policy agenda forward.

1. Introduction

The policy challenge for cities can be simply stated: *The fate of the Earth's climate and the vulnerability of human society to climate change are intrinsically linked to the way the cities develop over the coming decades and century.*³ Roughly half of the world's population live in cities, and this share is increasing yearly and is projected to reach 60% by 2030 (OECD 2008; Figure 1). Most of the urban population growth will occur in developing countries which are projected to have urban growth rates roughly double those of OECD countries in the 2005-2030 timeframe.

Cities also contribute a large proportion of national GDP, both individually and in the aggregate, and can thus be expected to be the dominant hubs of economic activity for every nation. While this is especially true in the developed world, it is increasingly the case in the context of developing countries. For this reason, cities provide not only jobs but also a variety of social, environmental and cultural services to people around the world (OECD 2008). This concentration of population and economic activity, however, also makes cities particularly vulnerable to climate change as they are the home to valuable built infrastructure as well as to large numbers of the world's poor.

Figure 1. World population trends – urban – rural breakdown



Source: Based on data from the United Nations (2006) as cited in OECD 2008.

Due to their concentration of economic activity and people, cities can provide economies of scale and potential opportunities to provide innovative solutions to such complex environmental problems as climate change. A recent IEA analysis estimates that cities account for 60-80% of world energy use (IEA, 2008), which also suggests that the way cities develop and how they mitigate energy-related emissions will be key to successful climate policy. Looked at from another perspective, the mitigation of greenhouse gas emissions at city-scale will deliver not only global benefits in the form of avoided climate change but also local co-benefits, including cleaner air, quieter and greener outdoor spaces and, in some instances, more jobs in new “green” business areas such as clean energy or waste recycling and reuse (OECD, 2000; Bollen *et al.*, 2009).

Table 1. Land, population and GDP of selected cities as a share of the country total

City	Brussels	Budapest	Lisbon	Mexico City	New York	Paris	Seoul	Sydney
Per cent of land	2.3	0.8	3.2	0.1	0.1	0.5	0.6	0.02
Per cent of population	10	25.3	26.3	23.9	7.8	21.2	25	24.4
Per cent of GDP	44.4	45.6	38	26.7	8.5	27.9	48.6	23.5

Note: These data should be interpreted carefully. Due to data availability, data sources for each factor are different. There could be a significant discrepancy between data sources regarding the boundaries of cities, except for Lisbon whose data was provided by the Portuguese National Institute of Statistics (population of 2005, GDP of 2003).

Sources: OECD Env Outlook 2030.

There is some evidence that cities can be effective agents of change and centres of innovation to address climate change. A growing number of cities have initiated bottom-up initiatives to add greenhouse gas reduction to city policy objectives (Bintliff *et al.*, 2007; Bulkeley and Betsil, 2005; Betsill and Bulkeley, 2007). Indeed, cities have begun to work together in transnational networks to strengthen greenhouse gas reduction efforts and learning, including through combining their purchasing power to achieve common goals such as improved energy performance of public buildings (*e.g.*, C-40 2008; Betsill and Bulkeley, 2007).

Impacts, vulnerability and adaptation to climate change have received significantly less attention than mitigation opportunities at city-scale, despite some evidence that cities could be hard hit by

shifting climate patterns and extremes (Baettig *et al.*, 2007). The European heat wave in 2003 for example in Paris (Beniston, 2004; Schaer *et al.*, 2004) and the landfall of Hurricane Katrina in the city of New Orleans in 2005 (Hallegatte, 2006) are two prime examples of the types of extremes that could become more common with a changing climate. As such, there is a small, but, growing academic literature on city-scale vulnerability and adaptation (see Hallegatte *et al.*, 2008 for a review). Furthermore, a few cities appear to be at the forefront of adaptation planning and implementation (*e.g.*, Chicago, London, Miami, Paris, Toronto)⁴ and a number of umbrella groups have grown up to assist cities to learn from each other as they develop capacity and experience in this area.⁵

Despite increasing levels of attention and action at the city scales, much of this activity is largely decoupled from national policy frameworks. Moreover little policy analysis or research has considered the issue of the multilevel governance of climate change and the unique role of cities is within such a framework.⁶ A key issue for national policymakers is what they can do to empower cities to become effective in the design and implementation of policies for mitigation and adaptation to climate change and to take advantage of the opportunities to learn from city-scale experimentation with a range of different climate response policies.

This paper highlights the nature of the policy challenge to address climate change at urban scale within the broader domestic policy context. After briefly reviewing the nature of the policy challenge, it outlines two areas for priority attention for “linked up” action across scales of governance on climate change.

2. The policy challenge

Climate change poses a difficult, intergenerational challenge, since the decisions being made today will shape the climate for future generations. Choices about the way we produce and use energy, about transportation modes, about what and how much we consume, and also about land use will influence GHG emissions in the coming decades. Inaction will commit us to a rapidly changing climate and a range of possible climate surprises. These could include the melting of the Greenland ice sheet and possibly the West Antarctic, an extreme but not altogether unlikely scenario that could raise sea levels by as much as 7 meters over centuries to come and effectively flood many of the world’s existing coastal cities (Hansen, 2007; Rahmstorf, 2007). Equally, ocean acidification resulting from increasing CO₂ concentration could have wide-ranging effects on marine systems and the food chain more broadly (Caldeira and Wickett, 2003). Potential impacts – some already being observed today – include increased intensity of heat waves, with direct effects on human health particularly in cities, where there is an urban heat island effect; increases in intense rainfall events, which increase the risk of inland flooding; retreat of mountain glaciers, with impacts on water availability and quality in urban regions; and an increased risk of drought and water shortage in already dry regions (IPCC, 2007b). Furthermore, changes in temperature and the hydrological cycle will most likely shorten the maintenance and replacement cycle for key infrastructure (*e.g.*, energy production, transport, etc.) as well as influence their operational capacity (brownout and blackouts; service interruptions) if not addressed (Mansanet-Bataller *et al.*, 2008; Cochran *et al.*, 2009). Action must be two-pronged: the earlier and more cost-effective our action to mitigate GHG, the more we can do to protect the climate and limit the risk of dangerous climate change. Equally, the earlier we adapt, the more we can cost-effectively protect people and infrastructure from dangerous impacts of inevitable climate change (IPCC, 2007a; Stern, 2007; OECD 2008).

With respect to vulnerability, it is important to recall that physical exposure to climate change will not discriminate between the rich and the poor. However, the poor are expected to be more vulnerable due in part to the lack of resources and capacity to respond in a timely manner. As Hurricane Katrina reminded us, climate extremes are likely to fall the hardest on the poor (Mathew,

2007), who lack the resources to respond quickly and effectively to protect themselves from extreme weather patterns. The urban poor are also more exposed to climate change, since they are likely to occupy on the cheapest land, sometimes illegally, or un-developed floodplain areas such as the Dharavi slums in Mumbai and the New Orleans' 9th Ward. The high vulnerability of the urban poor to climate change makes cities a key centre for design and implementation of anticipatory adaptation action.

In this light, a first priority for cities is to better understand the risks of climate change, in particular from the probable increase in the intensity and possibly the frequency of extreme events in the century to come. Vulnerability to climate change depends upon cities' physical, social and institutional characteristics, for example, on the vintage and location of building stock and other infrastructure, as well as on the types of businesses operating in a city and how public services are provided. City structure and density are defined over time; reducing vulnerability may also take concerted effort over a relatively long period. Since today's decisions whether to invest in new or refurbished infrastructure will have a critical influence on the future vulnerability of cities to climatic changes, it is necessary for decision-makers to anticipate these changes. Understanding the risks of climate change at city-scale can help cities to better work in tandem with the national government to manage national risks more efficiently.

One critical issue is to understand the urban development interface with climate change. A large proportion of the world's population resides in coastal zones, which are likely to be hard hit from rising sea levels and intensifying storm surges.⁷ Recent OECD work shows how a 50-cm sea level rise due to climate change combined with socio-economic development patterns could lead to a tripling of the population exposed to coastal flooding by 2070 and a tenfold increase in asset exposure, increasing the value of exposed assets from about USD 3 trillion to USD 35 trillion, *i.e.*, from 5% of today GDP to 9% of 2070's GDP (Nicholls *et al.*, 2008). We estimate that about two-thirds of this increase in exposure is driven by socio-economic development whereas climate change amplifies the exposure by one-third. The most affected port cities are found not only in rapidly growing developing countries (*e.g.*, Kolkata, Shanghai, Guangzhou) but also in some of the most wealthy of countries worldwide, including the United States (*e.g.*, Miami, New York City), the Netherlands (*e.g.*, Rotterdam, Amsterdam) and Japan (*e.g.*, Tokyo, Osaka).

To some extent, citizens, cities and nations have development choices that will exacerbate or limit the damage that climate change brings. These include decisions concerning the carbon intensity of growth as well as investment in adaptive measures to limit vulnerability and exposure to extreme events today and in the future. Any political decision to deal with climate change inevitably involves balance and the tension amongst a range of choices: the balance of effort to adapt "now versus later" to a range of uncertain climate changes and tension between different types of effort, such as to "mitigate and/or adapt" in any particular regional setting (Corfee-Morlot, 2009). Climate changes are increasingly observed in real time, and projections on a regional scale have become increasingly reliable and robust. Both developments have increased the importance of making decisions about adaptation and mitigation today, particularly on the sub-national or local scales (Cash and Moser, 2000).

Just as cities are part of the climate problem, they are also part of the solution (Hallegatte *et al.*, 2008; OECD, 2009, forthcoming). The right choice of urban policies is particularly important to ensure that long-lived infrastructure – commercial and residential buildings, roads and ports, water and transport networks – is designed to withstand the expected increase in climate hazards while simultaneously improving the energy and emission performance of the built environment. Integrated urban planning is central to land use decisions and zoning that may exacerbate or limit the exposure and vulnerability of urban dwellers and infrastructure to the growing threat of climate

change. Similar issues pertain to mitigation, for example, in transportation and land-use planning which is key both to improving accessibility while at the same time to reducing the demand for mobility and emissions.

3. Developing the toolbox to harness city-scale decision making

Cities and other sub-national governments hold the unique potential to work closely with local constituencies to develop visions of the future that match the needs of these constituents (Moser and Dilling 2006; Brunner, 1996). At smaller geographic scales, experimentation and learning can be expected to be more rapid and lessons learnt can disseminate more quickly than otherwise and lessons from such experience may filter up or over to influence action elsewhere (Corfee-Morlot, 2009). However, cities cannot operate effectively in isolation from other parts of government.

Not surprisingly, recent trends in national policy making reflect the emergence of multi-level governance on climate change, operating vertically across multiples levels of government (*e.g.*, local to national) and horizontally across governmental departments as well as non-governmental actors (UNFCCC, 2006; Bulkeley and Betsill, 2005). Although political interest in climate change may initially have emerged through international or national policy processes, regional and local decisions are critically important to the design and implementation of adaptation strategies to respond to climate change. While, regional and local policies may determine land use, human settlement patterns and transportation planning, the local governmental authority to act in these areas is almost always hierarchically “nested” in legal and institutional frameworks at national or sub-national level (Dietz *et al.* 2003; Hooghe and Marks, 2003).

How can cities best contribute to international efforts to address climate change and how can national governments help cities to do this? We outline two core activities that national governments could support to help cities become more effective in the design and delivery of locally-adapted policy solutions to climate change. First is the issue of developing city-scale GHG inventories such that mitigation performance can be monitored and compared across urban jurisdictions. Second is the need for regional science-policy capacity to support timely and cost-effective adaptation at local scale. Progress in both of these areas could build crucial capacity at local scale to address climate change and both require support from national governments. In the case of GHG inventories, international attention to the challenge is also required to advance the development of the necessary tools.

3.1 Monitoring progress: cities, mitigation and GHG inventories

Cities have been active in efforts to reduce greenhouse emissions for at least a decade and the level of ambition and scale of statements of intent to mitigate have grown with time. For example, following an initiative of city of Seattle’s Mayor Greg Nickels, in 2005 more than 130 US cities announced plans to achieve Kyoto-like emission reductions (Brown, 2005). These ambitious goals imply bringing city emissions to below 1990 levels by 2012. Cities may or may not achieve these hortatory goals, but they will learn from their experience. And the next steps will be easier due to their leadership efforts.

However, there is a need for cities to bring rigour and structure into their efforts to measure progress in achieving their mitigation goals. Today we still lack harmonised, internationally agreed methods and inventory data to assess progress within and across cities.

Without better tools for comparable emission reporting and performance assessment, it will be difficult to share experience and lessons from city mitigation efforts. One prerequisite is to establish a common set of metrics for comparison of progress across cities. Agreement on metrics, methods and

common reporting frameworks for cities can establish a common language for cities to speak to each other, to measure progress and assess performance (both ex ante and ex post policy implementation), to identify and share understanding of best practices in urban-scale mitigation activities. Also, emerging carbon markets combined with harmonised inventory methods, reporting and data sets at local levels could provide cities a starting point to access to carbon-finance to leverage their otherwise limited resources.

This recommendation draws on past experience in the building of reliable and transparent international monitoring systems to support improved environmental decision making and performance. In the late 1980s, the OECD began working with governments to develop harmonised GHG accounting methods and reporting systems. At that time, a number of industrialised countries had pledged to reduce GHG emissions following the landmark Toronto Conference on the Global Atmosphere (World Meteorological Organisation, WMO/OMM, 1988). Yet there was no way to accurately assess and compare national efforts since at the time there was no standardised inventory system to account for national GHG emissions. The OECD was tasked to work with experts and governments to agree and to establish a system of harmonised methods and a reporting framework to enable governments to communicate with each other on the issue of GHG mitigation (Corfee-Morlot and Schwengels, 1994). It took several years to develop and pilot a system; as the effort became more firmly institutionalised, the work of the OECD in this area was handed off to the Intergovernmental Panel on Climate Change. The National Greenhouse Gas Inventories Programme (NGGIP) is now one of several technical support units of the IPCC and is operated out of Japan.⁸

Today parties under the UN Framework Convention on Climate Change (UNFCCC) have adopted the IPCC methods as a standard framework for preparation of national inventories. Furthermore, through the UNFCCC, a common national inventory reporting system is in place, as part of a broader set of national reporting requirements that is particularly structured and firmly established for industrialised countries (Yamin and Depledge, 2004). National GHG inventories, which are submitted annually by all industrialised (Annex I) Parties, provide solid, comparable and high-quality emissions data at the national level to support peer-review and transparent assessment of mitigation performance under the UN Framework Convention on Climate Change and the Kyoto Protocol.⁹ These data are the backbone of the international climate regime, allowing countries to monitor their performance over time. And, importantly this system, when combined with other tools to ensure quality of information and the ability to accurately track compliance and transactions, has enabled the creation of an international carbon market. That market has grown significantly in recent years, with total value to equal about USD 64 billion by 2007, more than doubling in value from 2006 (Capoor and Ambrosi, 2008).

If cities are serious about their interest to contribute to the global effort to limit emissions and protect the climate then they will work together to establish and use common inventory methods and a standard reporting framework. A common framework will allow cities to assess progress over time as well as across locations. It will also allow them to compare results and cost-effectiveness of emissions reductions at the sector level – for example in the waste sector, in the transport sector or residential or office or commercial building energy end-use sector.¹⁰ It will also allow them to consider how they stack up, for example in comparison to other cities of similar wealth, population, or geographic features, and to understand how and why major changes in emissions occur over time. In this way, it will open new possibilities for collaboration and learning. Standardised city inventories and datasets will also open opportunities for cities to become actors in the international carbon market, as providers or enablers of emission offsets.

Although some progress in making carbon finance available at urban scale is being made (Bodiguel *et al.*, 2008; Roberts 2008), much more could be done. With standardised measurement

approaches, city scale policies could lead to measurable emission reductions that are eligible for certification and sale through some existing mechanisms under the Kyoto Protocol (e.g., joint implementation or the clean development mechanism) or similar mechanisms that are expected for a post-2012 agreement. This could open the way for new sources of funding to city-scale mitigation efforts, helping cities to exploit least cost options for reducing emissions in the coming decades. Beyond further opening opportunities for carbon finance, harmonised inventory methods and reporting is essential to enable performance assessment and comparison across urban locations, for example to assist national decision-makers to understand the comparative cost-effectiveness of urban scale action, as well as to aggregate performance across locations to better understand the overall contribution from urban scale action.

3.1.1. The inventory challenge

What is standing in the way of inventory harmonisation at city-scale? Cities require solid technical input and international support to connect their inventory approaches or protocols to existing IPCC guidance and FCCC national reporting systems. Without these critical links to the institutional framework that has emerged to support international monitoring, review and verification process under the Convention, it will be difficult, if not impossible to integrate city-level mitigation action into emerging regulatory frameworks and markets for emission reductions.

Currently, a number of competing inventory protocols have been developed that are in use in data collection and inventory preparation at city level. The ICLEI Cities for Climate Protection program¹¹ has been active worldwide over the last decade to support mitigation action at the local level. Each of its more than 800 member local governments has committed to produce an emissions inventory using its “Clean Air and Climate Protection” software. Embedded in this software are a number of inventory methods and a simple reporting structure. However cities have wide choice in how they use this tool and the ICLEI guidance points out that it is a tool explicitly developed to enable city management of emissions over time rather than to permit cross-city comparisons.¹²

Assuming that comparability across entities is desirable, the IPCC guidance for national inventory preparation is a necessary starting point (UNFCCC, 2002a). For example, in response to the need for harmonised approaches for “entity-level” reporting, the World Resources Institute and the World Business Council for Sustainable Development (WBCSD) collaborated to develop “The Greenhouse Gas Protocol”, primarily for corporate use to track emissions (WRI/WBCSD). It builds on the IPCC guidance but develops it for use at a different level or scale of activity.¹³

Building on the WRI/WBCSD work, the California Climate Action Registry (CCAR), is the first state registry to have developed a standard inventory protocol and set of methods for inventory preparation by cities (CCAR, 2006). In describing that programme in 2006, Diane Wittenberg then president of CCAR said: “*The hardest part is boundaries, what’s in and what’s out... some of them are reporting [individual] buildings in the city, and others are skipping things like the airport. And you’ve got everything in between. ...so we’re looking forward to tightening up the way that cities are reporting.*” Also commenting on how to advance uptake and use of the protocol, Diane Wittenberg said: “*ICLEI ...would try and push this to other cities outside of California and let those states kind of take the ball with their own cities.*” In 2006, San Francisco became the first city in the United States to submit an inventory validated with the CCAR protocol, which focuses on city operations.¹⁴ More recently, a number of US states have formed “The Climate Registry” which is intended to establish a harmonised system for entity level reporting across participating states. This move could expand the influence of the CCAR city-scale protocol and see it extended more widely for use across the US. In addition, the US EPA is in the process of developing an official registry (Rich 2008),¹⁵ however it is unclear whether that registry will include a protocol to cover cities. Furthermore, ICLEI and the

Climate Registry are now working together to develop a standard protocol for wider diffusion across ICLEI members (see below).

In France, the Agence de l'Environnement et de la Maîtrise de l'Energie (ADEME) has created the Bilan Carbone (ADEME, 2008), an emissions accounting system developed for both corporate as well as municipal users. This looks at both city operations as well as emissions occurring within the geographic boundaries of cities, focusing on 10 primary emissions areas: energy generation, industrial processes, the service sector, residential, agriculture and fisheries, freight, passenger transport, construction, and waste disposal. The Bilan goes beyond direct and indirect emissions to include the emissions associated with products consumed (*e.g.*, emissions embedded in the production of cement used in city infrastructure) as well as the tourism-related air travel for destination cities. The ADEME has also established a structure both to train evaluators and to partially finance local-level inventories through grants. Many French cities have used the Bilan Carbon to evaluate their emission levels, however, as with the ICLEI inventory tool, cities have choices in what and how they choose to include in their inventory. As a result, application of Bilan Carbon leads to incommensurable results across cities.

To date no single protocol or set of process guidelines has been adopted to harmonise compilation of data, estimation of emissions or reporting of urban inventories. As a result, cities have taken different approaches in defining what sectors to include, in establishing the geographic boundaries of the area included, as well as in aggregating data in different ways. As such, any comparison across existing inventories is hampered.

3.1.2. A brief review of selected inventories: technical issues

A brief review of selected city inventories (Table 2) provides an overview of the range of technical issues embedded in the task of inventory preparation that influence comparability. Beyond differing reporting formats or inventory construction protocols (see above), these features include:

- Different definitions of the city (*i.e.*, is it defined by the larger metropolitan region or the city limits, or by something else);
- Choice of inventory years presented;
- Scope or boundaries of the inventory, *i.e.*, whether or not more than city-owned operations are reported, and whether indirect emissions are included or not: *e.g.*, treatment of electricity emissions;
- Methodological issues.

A look at each of these issues in turn provides insights to the complexity of developing comparable inventories. On definitions of the city boundary, city emission inventories tend to be divided into two categories: community-wide emissions, which correspond to all of the emissions related to the urban area's geographical boundaries, and city-operation emissions, which are those emissions produced by the municipal government itself. Table 2 considers a selected number of US and Canadian cities indicating the range of choices. Some urban areas limited their study to administrative boundaries (*e.g.*, Seattle, Toronto, New York City) while others chose to include the entire metropolitan zone and/or the surrounding region (*e.g.*, Vancouver, including the Lower Fraser Valley). The choice of inventory years also appears to vary widely across cities.

On the scope of GHG covered, the majority of the inventories outlined in Table 2 take both direct and indirect emissions into consideration. Direct emissions are those produced by operations occurring

in within local boundaries by local activities, such as transport, commercial and residential fuel combustion, industrial production or processes as well as the treatment of waste. Indirect emissions are those resulting from energy use or imports but where the emissions occur outside local boundaries (e.g., electricity or steam production). Inventories of city operations also include direct and indirect emission sources related to functioning of the city and the actions of its staff. Direct emissions include those associated with public utilities or public entities, but again occurring within city boundaries (e.g., electricity if it is publicly provided, water, etc.), buildings, vehicles and landfills. Indirect emissions primarily group energy imports, as above, but also include employee commuting, business-related air travel.

Central to the question of direct or indirect emissions accounting is how to deal with the electricity sector. Most often electricity is generated outside city boundaries but largely consumed within them, e.g., by residential and commercial customers (see Figure 2). Cities differ in the way they account for these emissions. For example, while some choose to

allocate emissions associated with power generation to the end user category, i.e., in terms of residential or possibly even further to water heating, lighting, other cities report electricity and heat/steam generation emissions as a separate category, and others not at all.

Beyond the challenge of addressing electricity emissions for urban energy use is that of how to address emissions embedded in products purchased and used in cities. For example, in the Seattle city-operations inventory includes emissions associated with concrete and asphalt manufacture (i.e., for road maintenance operations and other city infrastructure), even though these emissions may occur outside the city boundary. Furthermore, the French Bilan Carbone protocol, which is also designed to support city-scale inventory preparation, calls for including estimates of emissions for goods used within the urban area but produced elsewhere. In addition, a few cities attempt to factor the extra-urban travel behaviour of residents into totals. These more extended analyses represent the “carbon footprint” of urban consumption activities but go beyond the accounting of emissions within administrative geo-political boundaries, which has been adopted by the IPCC national GHG inventory guidelines (UNFCCC, 2002). However, accounting for city-scale carbon footprints could be an important tool and source of information to support policies that target consumer behavioural change to limit emissions. They can therefore usefully be added to inventories, but for consistency of reporting purposes must be separable.

Another important boundary question is how emissions from the transport sector are accounted for. Here the key issue is how to estimate and link emissions from this sector to the urban area. Typically this would be based on standard measures of activity, such as fuel consumed in the transport sector within the geographic area of concern. However at city scale, these data are often not available. Alternatively, proxies based on distance travelled or the indicator of vehicle miles travelled can be developed. But there is no harmonised approach or broad agreement on how best to allocate a share of national or regional transport activities to urban areas. A variety of different models and assumptions are possible, each with different outcomes.

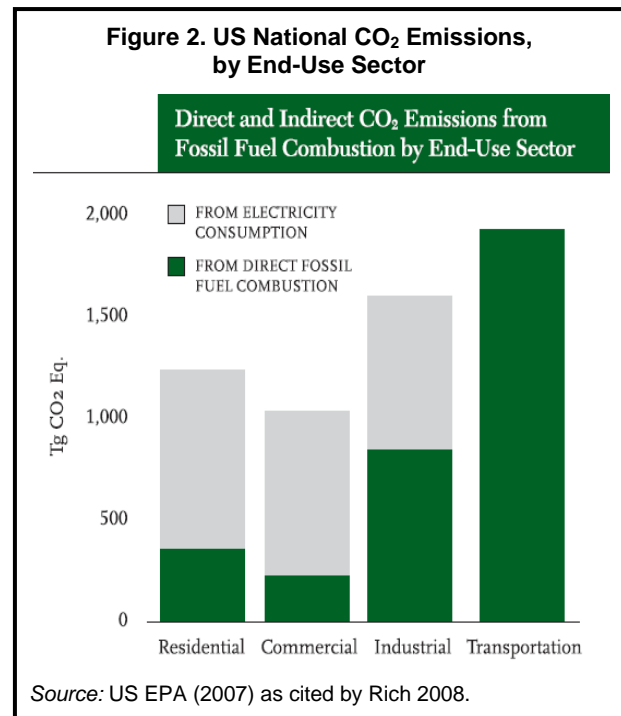


Table 2. Selected city-scale GHG inventory reports: comparison of key features

<i>Basic Information</i>		<i>Inventory</i>						
City	Region	Population	Metro	ICLEI CCP	Data yr(s)	Indirect	City Operations Breakout	Protocol
Seattle	WA	573 911	City limits	Yes	1990, 2005	Yes	Yes	GHG Protocol; IPCC National Guidelines
Vancouver	B.C.	2 600 000	Lower Fraser Valley	Yes	2005	No	N/A	IPCC National Guidelines
New York City	NY	18 815 988	NYC Metropolitan Region	Yes	1995, 2000, 2005	Yes	Yes	CCAP ICLEI
San Diego	CA	1 291 700	City Limits	Yes	1990, 2004	Yes	Yes	n/a
Toronto	ON	2 503 281	City limits	Yes	2004	Yes	Yes	CCAP ICLEI
San Francisco	CA	7 264 667	County	Yes	2005	Yes	Only	CCAR
Columbia	MO	99 174	City limits	Yes	2000, 2005	N/A	No	CCAP ICLEI
Northampton	MA	28 978	City limits	Yes	2000	Yes	Yes	CCAP ICLEI
Palo Alto	CA	61 200	City limits	No	2005	Yes	Only	CCAR
Sacramento	CA	475 743	City limits	Yes	2004	Yes	Only	CCAR
Santa Barbara	CA	90 400	City limits	No	2005	Yes	Only	CCAR
Somerville	MA	77 478	City limits	Yes	1997, 1999	Yes	Yes	CCAR

Sources: 2005 Inventory of Seattle Greenhouse Gas Emissions: Community and Corporate; 2005 Lower Fraser Valley Air Emissions Inventory and Forecast and Backcast; Inventory of New York City Greenhouse Gas Emissions; City of San Diego Greenhouse Gas Emission Inventory; Greenhouse Gases and Air Pollutants in the City of Toronto : Toward a Harmonized Strategy for Reducing Emissions; Annual Emission Report: City of San Francisco; City of Columbia Emissions Inventory; Executive Summary Greenhouse Gas Emissions Inventory Summer Internship, 2001 Cities for Climate Protection Campaign City of Northampton; Annual Emissions Report: City of Palo Alto; Annual Emissions Report: City of Sacramento; Annual Emissions Report: City of Santa Barbara; Greenhouse Gas Emissions Inventory Report: Including Recommendations for the Emissions Reduction Plan

Finally, there are other methodological differences associated with individual emission source categories. These include, for example, how to estimate the emission factor for electricity, when emissions will vary by type of primary energy used to generate electricity? Beyond limiting the ability to compare emissions between cities, the level of aggregation and choice of methods to estimate and report emissions may alter the usefulness of the inventory for policy development. These differences suggest the urgent need for a harmonised set of methods and reporting protocols.

3.1.3. Towards harmonised reporting, comparable data

While a number of different protocols exist, an increasing number of cities have undertaken urban emission inventories in recent years. Yet to date, only two programmes are attempting to consolidate these inventories using a formalised reporting process. First is the ICLEI CCP campaign noted above. However given the lack of standardisation in reporting or inventory construction, the city inventories prepared under the ICLEI effort are used to monitor performance across time within a single city rather than to compare performance or trends across cities. Second, the Climate Alliance's Local Governments Climate Partnership is also working to compile and compare emissions data from participating cities in Germany, the United States and Japan (Climate Alliance, 2008).¹⁶ This program was launched in early 2008 and has not as of date reported its results.

Making city GHG inventories comparable will require agreement on a common format for reporting as well as key methodological issues. Consensus will be needed on how to treat key issues such as those outlined above in a consistent manner. Even if cities are given the flexibility to construct inventories with different boundaries (*e.g.*, in terms of reporting direct and indirect GHG emissions), at a minimum it will be necessary to report these in a modular manner such that comparable estimates could be constructed. Due to the high costs associated with producing the quality of data necessary to produce emission inventories, it will most likely be necessary to find a middle ground, with enough detail to remain useful, but not so onerous as to make its production burdensome or financially unfeasible for local budgets.

As with the challenge of developing firm-level reporting guidance – which was led by WRI/WBCSD – the tools that cities use to monitor progress will need to be linked up or nested in the IPCC GHG inventory guidance to avoid double-counting with other local authorities or even across sectors as national governments establish nationwide policy frameworks. It will require support and resources from both national governments and the international community, including from experts engaged in the review and monitoring taking place under the Convention. While it would take time and resources to get such a system up and running, it would be one step in the right direction to empower cities in their efforts to achieve cost-effective GHG emission reductions.

Regarding standard methods and reporting protocols, the ICLEI Cities for Climate Protection (CCP) network – one of the oldest of the city networks on this issue – is currently developing a city-level protocol and guidelines. This work was originally slated for delivery in 2008 (this may now have slipped to 2009); it features co-operation with the World Resources Institute and the California Climate Action Registry (CCAR). This appears to be an excellent start. However, to be fully operational and accepted, the product of its work will need to be vetted and eventually endorsed by institutions formally charged with establishing monitoring requirements at national and international scales (*i.e.*, the IPCC).

3.2 Assessing local impacts through sub-national science-policy exchange

The second priority for national-local collaboration is on science-policy capacity building and information. The aim of any such effort should be to establish a capacity to improve understanding

about how climate change will affect cities. More detailed regional impact assessments, in turn, could be expected to influence the politics of climate change from the global to the local scale (Harris, 2001; Shackley and Deanwood, 2002). Importantly, regional impact and vulnerability assessments facilitate reflection about both adaptation and mitigation. That is, it supports dialogue and discussion about what types of risks are of greatest concern to affected populations and what adaptations might limit climate change impacts, and it facilitates communication about what climate change is and why we need to do something about it to mitigate emissions (Corfee-Morlot, 2007).

Some amount of climate change is unavoidable no matter how much we mitigate. To understand and properly assess adaptation options, cities require information from scientific impact assessments to consider how climate change may play out in local contexts to impact people, urban settlements and infrastructure. What will the temperatures of the 2020s or 2030s be? How will flood risk change in the coming five years or more? And how will these climate changes interface with urban environments?

Climate science over the last decade or so has focused on large, global models that integrated different types of physical models to predict how the atmosphere will interact with oceans to change climate over time (IPCC, 2007). There is little regional information coming out of these science assessments so working at local or sub-national levels requires another layer of effort and a special set of tools to scale down or relate global change predictions to local or regional conditions (Hallegatte *et al.*, 2008). This can be done in a variety of different ways, but it takes time, expertise and money. It is research-oriented rather than policy-oriented work and organising funding and institutional capacity to make it happen in a timely manner can be difficult.

Establishing capacity to generate and use impact assessment information at local or sub-national scale is a science policy exercise that presents a range of technical and procedural or institutional challenges.

On the technical issues, a recent OECD working paper proposes a framework to guide local scale impact assessment, including how global modelling results can be translated to a city scale as well as various issues in assessing climate impacts through use of a range of metrics (physical and monetary) and costs of responses under different conditions. In particular, it lays a conceptual approach to assess the avoided-impact benefits and the co-benefits of local adaptation and global mitigation (under different adaptation scenarios) (Hallegatte *et al.*, 2008). Moreover, two city case studies – Copenhagen (Hallegatte *et al.*, 2008) and Mumbai (OECD, 2009b forthcoming) are being conducted to test and refine this framework.¹⁷ Beyond providing original and detailed assessments of climate change impacts in these locations in the 2070s/2080s timeframes, these studies are also proving to be vehicles for engagement across key stakeholders in these locations. In particular, they are serving to stimulate dialogue among affected stakeholders across difficult questions such as what priorities to establish for adaptation investments given the range of possible outcomes surrounding uncertain climate projections (Hallegatte *et al.*, 2008). This highlights that procedural issues are also important, *i.e.*, it is insufficient to have good scientific or technical analysis. To make good decisions requires active reflection and dialogue between expert and stakeholder communities.

On the procedural or institutional side, there is a need for active interaction between customers for information – policy makers and other decision makers and the information suppliers – scientists and other experts (Stern and Fineberg, 1996). There are a number of notable examples featuring state-of-the-art deliberative processes to engage stakeholders from the start to shape the framings and findings of assessments. In Canada, for example, there is now some experience with regional (sub-national) participatory integrated assessment to support watershed management and climate change adaptation decision-making (Cohen *et al.*, 2004b; Vescovi *et al.*, 2007; Yin and Cohen 1994). An example of multi-lateral collaboration using deliberative methods exists in the recent assessment of

the Arctic region. The Arctic Climate Impact Assessment was published in 2004 and, importantly, sponsored by the Arctic Council, which represents eight member-state governments (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States) and six permanent participants including two indigenous peoples' non-governmental organisations (ACIA, 2004).¹⁸ This study was unique as it was both deliberative, employing a number of different methods to engage affected stakeholders, as well as an international process to facilitate deliberation among state actors with an interest in the region.

Relatively recent policy-driven scientific efforts to predict regional climate changes are also found at local and regional scales, for example, in the United Kingdom (McKenzie Hedger *et al.*, 2006; West and Gawith, 2005) and in the United States (Hayhoe *et al.*, 2004; Moser, 2005; Parson *et al.*, 2003). The UK programme is somewhat unique in that it is initiated, organised and to a great extent funded by local and regional stakeholders, although the institutional mechanism overseeing the co-ordination of such regional efforts is national (McKenzie Hedger *et al.*, 2006). Some of the results from the UKCIP suggest that cities provide a useful spatial scale for the stakeholder engagement in decision making. In the US, initial climate impact assessment was conducted through an extensive nationwide effort (NAST, 2000). This national process featured a broad-based consultative process to engage local stakeholders across different regions of the United States in the preparation and vetting of these reports (Moser, 2005; Parson *et al.*, 2003). Although the national process in the United States after 2000, with the change in administration under President George W. Bush, the regional networks of people who worked on these studies have continued to support regional impact assessments in state and/or non-governmental venues (*e.g.*, in the case of California, see Corfee-Morlot, 2009).

Funding for such work will inevitably need to come from national governments or relevant sub-national authorities as it can be useful to stimulate adaptation across urban regions in an entire nation or region. Often the work will be carried out in local research centres or universities and joined up through "boundary organisations" to policy or other decision-makers. Again the lead time is long, often requiring nearly a decade to build significant expertise and competence in this area, hence the need to start today.

Table 3 highlights a number of different institutional models that have grown up in different places around the world to provide science policy support for impact analysis and adaptation policy decision making. In looking across the organisations studied, there is broad variation in their geographic scope and proximity to "local" clients, levels and sources of funding and key roles or functions of the organisation (see also Annex). However, there are also a number of common features. All of them focus on the same audience: stakeholders, local decision makers and citizens. Further, the organisations have various ways of interacting with the scientific community, acting either as consumers or as suppliers of new scientific information. But they all target the same goal, which is to facilitate stakeholder and decision makers' access to scientific information. Finally, all the institutions also target use of the local scientific community to contribute relevant information, working through universities, local and national institutions and research centres.

Table 3. Institutional models for climate change information development and exchange

Organisation	Geographic Scope and Key Role	Clients/Audience	Interaction with Scientific Community	Source of Expertise	Lead Organisation	Core Funding
IRI - International Research Institute for Climate and Society	Africa/Asia Pacific/Latin America <ul style="list-style-type: none"> • Understanding local decision process; • Sharing climate information to meet the needs of the decision makers; • Linking institutions and build capacities to improve climate risks management; • Develop climate information generating tools that meet local decision makers' needs. 	<ul style="list-style-type: none"> • Developing countries' decision makers • Developing countries' public/private sector • Developing countries' citizen 	Suppliers	<ul style="list-style-type: none"> • Columbia University Depending on the region: • National/local Institutions • NGOs • Research centers 	Host Institution: <ul style="list-style-type: none"> • University of Columbia Funders: Public and Private Sectors <ul style="list-style-type: none"> • NOAA Office of Global Problems • Several Organisations involved in project funding 	Public/private \$9M/Year
Ouranos	North America/Canada/Québec <ul style="list-style-type: none"> • Develop knowledge; • Co-ordinate multidisciplinary initiatives; • Help decision makers to integrated adaptation to climate change into their decision processes. 	<ul style="list-style-type: none"> • Local decision makers • Local stakeholders • Researchers 	Suppliers	<ul style="list-style-type: none"> • Federal agencies • Local and national universities • National research centers • Ouranos 	Funders : Public and private sectors <ul style="list-style-type: none"> • Government of Quebec • Valorisation-Recherche Quebec • Hydro-Québec 	Public/private \$12M/Year
PIER-EA - Public Interest Energy Research, Environmental Area	California/USA <ul style="list-style-type: none"> • Conduct and fund research in the public interest; • Research the environmental effects of different energy technologies used in California; • Attract collaborators to share data and work conjointly to develop mitigation strategies; • Develop California's capability to make informed decisions on climate change mitigation. 	<ul style="list-style-type: none"> • Californian decision makers • Private sector • Researchers 	Consumers	<ul style="list-style-type: none"> • Federal agencies • California State Agencies • Nonprofit groups and academic • Private laboratories 	Host institution : <ul style="list-style-type: none"> • California Energy Commission Funders : Public <ul style="list-style-type: none"> • Charge on retail electricity sales 	Public \$6M/Year
UKCIP - United Kingdom Climate Impact Programme	United Kingdom localities <ul style="list-style-type: none"> • Communicate information on climate change impacts to stakeholders; • Provide policy-making tools to decision makers; • Establish relationships between researchers and decision makers. 	<ul style="list-style-type: none"> • Local decision makers • Local stakeholders • Researchers 	Consumers	<ul style="list-style-type: none"> • Oxford University Centre for the Environment • Tyndall Centre • Research groups within universities across the UK • Private laboratories 	Host institution: <ul style="list-style-type: none"> • Oxford University Funders: Public & local resources <ul style="list-style-type: none"> • UK Department for Environment, Food and Rural Affairs • UK's Knowledge Transfer Partnership scheme 	Public/private \$1.25M/Year
Club ViTeCC, Villes, Territoires et Changement Climatique	France <ul style="list-style-type: none"> • Provide information to stakeholders, institutions and private sector on their roles in climate change adaptation; • Propose concrete recommendations for funding new infrastructures; • Make scientific and technical information understandable to local decision makers and developing the proper decision tools. 	<ul style="list-style-type: none"> • Local authorities • Stakeholders • Private and public sectors 	Consumers	<ul style="list-style-type: none"> • Private/public services • National meteorological center • National and international Universities • Known local and international experts 	Host institution : <ul style="list-style-type: none"> • Caisse des Dépôts • Météo France • ONERC Funders : Private/public <ul style="list-style-type: none"> • Contributions from clients 	Public/private N/A

Websites: <http://portal.iri.columbia.edu/portal/server.pt>; <http://www.ouranos.ca/>; <http://www.climatechange.ca.gov/research/climate.html>; <http://www.ukcip.org.uk/>; <http://www.caissedesdepots.fr/spip.php?article647>

Developing climate change information relevant to local decision makers is part of an iterative process engaging researchers and stakeholders in an ongoing exchange. Beyond engaging relevant participants, a first task is to establish a discursive process that allows ongoing exchange so that core research questions are framed with input from decision makers and decisions are made in local contexts based on the best available information from the scientific community. Up-to-date information on climate change impacts provides a basis for communication with stakeholders and a means to generate dialogue and understanding about the need for policy reform and behavioural change to respond to climate change. Information on climate change impacts provides a means for lay people to understand and care about the issue. It brings the abstract and distant problem of climate change into a local context and helps people – investors and consumers alike – to relate it to their daily lives and think about how to address it. It provides at once a motivation for mitigation and a powerful source of information for adaptation. Adaptation is necessarily local and will include disaster management to address nearer-term impacts such as floods, water shortage or heat waves. It will also include urban planning solutions to ensure that infrastructure and land use planning is resilient to climate change.

Furthermore, local stakeholders can provide essential input to impact researchers to yield results that are most relevant to their concerns. Growing experience with regional science policy processes demonstrates the value and ability to frame regional impact and vulnerability assessments around themes that are identified by affected stakeholders, to deepen knowledge and promote strategies for adaptation that resonate from the bottom up.

4. Conclusions

Despite a flurry of recent activity in cities on climate change and growing interest in the research community, climate policy at city-scale remains fragmented and basic tools to facilitate good decision making are still lacking. Action on climate change at city-scale is necessarily nested in the authority of national governments to advance the policy agenda, yet national governments have only just begun to take notice of the importance of cities in their efforts to advance policy. Yet this review joins others to suggest that cities may have a number of unique advantages in the design and implementation of locally-adapted responses. These include: i) the ability of cities to work closely with local stakeholders and in context specific ways to make climate change more tractable for decision makers; ii) the possibility for cities to incorporate climate change into reform of pre-existing local policies and practices (*e.g.*, land use and urban planning); and iii) the ability of cities to experiment with and learn about a range of possible responses to both cost-effectively adapt to inevitable climate changes and to mitigate greenhouse gas emissions.

Cities are central to our efforts to understand, communicate and act to limit and adapt to climate change. Communication strategies will benefit from the use of image and metaphor to connect climate change to local geography and culture (Leiserowitz 2005; Corfee-Morlot 2009). Climate change cannot remain a specialist issue; it needs to become a community issue, along with safe streets, clean air and good schools. The key to good decision making is engagement and understanding about the issue. Understanding climate change in local contexts, in turn, will bring political support for action, local know-how and ideas about how to address it to the table.

National governments have the opportunity to help or to hinder city competence on climate change. We have argued for two priority types of action that will empower cities on this issue. Working with sub-national and national governments, as well as with the international community, cities could help to contribute to cost-effective solutions by the development of:

- Harmonised GHG emission inventory and reporting protocols for cities to allow them to monitor and compare progress in mitigating emissions and eventually to become active participants in international carbon markets; and
- Regional impact science programmes to support local communication efforts on climate change and adaptation decision-making.

While the agenda for multi level governance of climate change is inevitably much broader than this, first steps by national governments to work with sub-national governments, cities and experts to advance capacity and tools in these two areas could be important first steps to move such an agenda forward. National enabling frameworks will be essential to support cities to design and deliver cost-effective and locally adapted policies to address climate change in urban areas. In this context, they will need to resolve the inevitable jurisdictional overlaps and issues of mandate. National governments will need to work closely with the international community, *i.e.*, to ensure that there is legitimate policy space for cities to participate, for example in market mechanisms in a post-2012 agreement. These are enabling activities that if tackled today could carry cities forward to deliver on the promise of climate protection over the decades to come.

ANNEX: INFORMATION ON REGIONAL IMPACT SCIENCE-POLICY INSTITUTIONS

IRI

Created in 1996, the International Research Institute for Climate and Society (IRI) collaborates with local institutions and stakeholders that understand local needs in Africa, Asia and Latin America. After having studied the region's basic social structure, the IRI chooses the regions and partners it wants to be involved with (Agrawala *et al.*, 2001). It focuses on its partners' climate risks management strategies and aims at strengthening them through the integration of climate risk management. "IRI participates in the transnational flow of technical knowledge and skills, usually along a gradient from North to South" (Agrawala *et al.*, 2001). Their research and tools help address development and adaptation issues in developing countries (IRI, 2007). IRI works collaboratively with the local and national partners to help them better plan and manage activities. Its climate change projects focus on actions needed to improve actual outcomes and the future interactions of environmental, economic and social systems with the climate (IRI, 2008). Their focus is on four major points (IRI, 2007): (1) understanding the local decision process; (2) sharing useful climate information to meet the needs of the decision makers, disentangling short-term from long-term issues; (3) linking institutions and building capacities to improve climate risk management; (4) developing climate information and generating tools that meets the local decision makers needs.

Ouranos

Ouranos was created in 2001 in a joint initiative by the government of Quebec, Hydro-Québec and Environment Canada to provide them with an organisation capable of linking climate science with the needs of different sectors of society. Its mission is to acquire and develop knowledge on climate change in order to inform decision makers about probable climate trends and advise them on identifying, assessing, promoting and implementing local and regional adaptation strategies (Ouranos, 2008). This involves developing structures for analysis of multidisciplinary problems, promoting synergetic work, developing tools or climate scenarios required to support vulnerability and impact assessments, and develop adaptation strategies (Vescovi *et al.*, 2007). Among its partners, eight provincial departments and agencies are involved, along with three universities. Ouranos can also provide external clients and stakeholders with reliable regional climate projections. Ouranos meets the needs of its partners from various sectors and defines effective adaptation strategies according to the specific needs (Ouranos, 2008). The communication between climate specialists, impact researchers, and user groups is co-ordinated by Ouranos. Thus, evaluation of the potential impacts is ensured and the development of adaptation solutions is facilitated (Vescovi *et al.* 2007). The organisation's budget amounts to about 5 million Canadian dollars (CAD) per year and is generating CAD 12 million of external resources (Ouranos, 2008b). Its source of funding mainly comes from Quebec's *Ministère du développement économique, de l'innovation et de l'exportation* (MDEIE). It also received, in 2008, CAD 10 million grant from the government of Quebec for its impact and adaptation work.

PIER programme

Over the last decade, the California Energy Commission (CEC) has developed the Public Interest Energy Research Programme (PIER), which includes an Environmental Area covering climate change

modelling and policy research (Franco, 2005). Part of the PIER mission is to conduct and fund research in the public interest that would otherwise not occur. The PIER programme, managed through the CEC, co-ordinates a broad-based research effort on climate change and solicits collaboration by partnering with research and development organisations, individuals, businesses, utilities, and public or private research institutions with experts throughout the state. The programme often leverages funding through this collaborative model, working with various institutions throughout the state. Ongoing national and international research efforts are the basis of its research program and funding of research projects to inform policy makers in the state (Franco *et al.*, 2008). In 2003, PIER programme created a five-year research plan on climate change in California. To implement it, the PIER programme created the (virtual) California Climate Change Center (CCCC), the first state sponsored climate research programme in the United States (Franco *et al.*, 2008). Although the Center is managed by the California Energy Commission, Scripps Institution of Oceanography at the University of California at San Diego and the University of California at Berkeley (CEC, 2008b), it draws on research partners across a broad network of universities and institutions across the state. A number of major outcomes include improved capability for California to make informed, economically grounded decisions on climate change mitigation and adaptation, including applications the management of water and agriculture, electricity and energy among other sectors (Franco *et al.*, 2008). PIER allocates roughly USD 4 million to USD 6 million per year to climate change research (CEC, 2008).

UKCIP

The United Kingdom Climate Impacts Programme (UKCIP) was founded in 1997 to help co-ordinate scientific climate change research, and to help organisations adapt to its impacts (UKCIP, 2008). To achieve its main objective, UKCIP works with scientists, policy makers and stakeholders to co-ordinate and influence climate research and to share the useful outputs with stakeholders. UKCIP supports the development of institutional capacity by raising stakeholders' awareness on the need to adapt and by providing tools allowing decision makers to make well-informed decisions when choosing adaptation strategies (McKenzie *et al.*, 2006). The Programme recognises that stakeholders can be experts in their domains and that the information provided by them allows researchers to use the best available regional information (McKenzie, 2006). It works on a contract basis with different sub-national regions or local communities to assess possible climate change impacts, vulnerability and adaptation options. While areas explored in the initial stages of a typical contract might include high impact-low probability events and to define the implications of climate impacts, the emphasis can rapidly shift to equipping stakeholders for adaptation (UKCIP, 2008), which in practice means combining the latest cutting-edge academic research with decision makers' knowledge of what works in practice (UKCIP, 2005). The majority of UKCIP's funding is from the Department for Environment, Food and Rural Affairs. Other contributors include the Environmental Change Institute (Oxford University) and the Government's Knowledge Transfer Partnership scheme (UKCIP, 2005).

Club ViTeCC – Villes, Territoires et Changement Climatique

The Club ViTeCC is a French research center focusing on the analysis of the carbon economy. It was created by a consortium of institutions in France including the *Mission Climat of Caisse des Dépôts, Météo-France* and the national observatory on climate change impacts (ONERC). In 2007 and in collaboration with these other institutions, the *Mission Climat* launched ViTeCC as part of its work in analysing the linkages between climate change mitigation, adaptation and urban infrastructures in France. Focused on cities, territories and climate change, Club ViTeCC's main objective is to provide local authorities, stakeholders, private and public sectors and citizens with information on their role in climate change mitigation and adaptation by bringing together economists, scientists and engineers for informal discussions (CDD, 2008). It aims to make scientific and technical information understandable to local decision makers and to develop the proper decision tools on emission reductions funding and

management of urban infrastructure adapted to future climate risks (*Association pour la Recherche en Economie du Carbon* or APREC, 2008). Equally, part of the Club ViTeCC's research program will focus on concrete recommendations for funding new infrastructures (APREC, 2008). The club brings together French local leaders (cities, towns, counties, regions, urban planning agencies etc.), management firms (energy, construction, transport, water, financial services) and recognized climate change and economic infrastructure experts. Its team is composed of members of the *Mission Climat*, *Météo France*, the National Observatory on the Effects of Climate Change (ONERC) and experts involved in a number of international research programmes. Participation in Club ViTeCC is subject to an annual fee (set for 2008 to EUR 4 000 for the public and EUR 16 000 for companies) dedicated to funding the operations and research conducted for the club. Club ViTeCC is a non-profit organisation, its funds are managed by the *Association pour la Recherche en Economie du Carbone* (APREC), founded by the *Mission Climat* of *Caisse des Depots* and the Université Paris Dauphine.

NOTES

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1. Organisation for Economic Co-operation and Development, Environment Directorate; Jan Corfee-Morlot is leading a project at the OECD on cities and climate change (see www.oecd.org/env/cc/cities) and is the corresponding author for this paper: jan.corfee-morlot@oecd.org. The views contained in this article are solely those of the co-authors and do not represent the views of the OECD or of its member countries.
 2. Mission Climat de la Caisse des Dépôts / CERNA - Mines ParisTech.
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 3. Opening statistics from: Tyndall Centre. 2004. A briefing on climate change and cities: Briefing Sheet 30, British Council. This statement is reworked from the Tyndall Centre report which argued "...the fate of the Earth's climate is intrinsically linked to how our cities develop over the coming decades" and thus focused uniquely on one dimension of this relationship.
 4. See Chicago Climate Action Plan (2008) and Parzen (2008); Greater London Authority (2008); Miami-Dade County Climate Change Advisory Task Force (2008); Mairie de Paris (2007); Toronto Environment Office (2008).
 5. See: Urban Leaders Adaptation Initiative www.ccap.org/index.php?component=programs&id=6; Alliance for Resilient Cities (ARC) www.cleanairpartnership.org/arc.php; and ICLEI's Climate Resilient Communities in the US and adaptation work in Europe: www.iclei.org/
 6. For example, the IPCC Fourth Assessment Report acknowledges the role of cities in design and delivery of climate responses is acknowledged and relevant academic literature reviewed, however it remains marginal to the full volume which is largely focused on the global dimensions of the problem and its possible solutions. For chapters that address local dimensions of climate change and policy responses see: Wilbanks and Romero *et al.*, 2007; Gupta and Tirpak *et al.*, 2007; Sathaye and Adjam *et al.*, 2007. Bulkeley and Betsill (2005) and Betsill and Bulkeley (2007) are notable exceptions in bringing attention to multi-level governance. The UNFCCC (2006) in their review of progress in national policy under the Kyoto Protocol also highlight some trends for national governments to work more closely with local governments.
 7. NOAA estimates that 53% of United States' population live in coastal regions (Crosset *et al.* 2004).
 8. For more information see: www.ipcc-nggip.iges.or.jp (last accessed 12 December 2008).

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9. For access to latest inventory reports and data see: www.unfccc.int (last accessed 8 December 2008).
10. Industry emissions may vary widely from location to location or even over time within a single location; *e.g.*, as industries increasingly move outside of city boundaries this may dramatically change urban emission levels. Decisions of city governments may also have little influence over industry emissions relative to large influence of local policy over residential and transport emissions. Thus special attention to this source of emissions may be warranted in the assessment and comparison of urban emission performance across cities.
11. ICLEI is the International Council for Local Environmental Initiatives, which now also operates a Cities for Climate Protection Campaign. See www.iclei.org/index.php?id=800 (accessed 12 November 2007).
12. www.icleiusa.org/cacp (last accessed 12 December 2008).
13. It is important to note that a number of different registries and protocols exist in the United States to serve different purposes, some of which are mentioned here. Because there is no single top-down mandatory federal system requiring entity or state-level reporting, a patchwork of state systems, some of which are mandatory, combine with voluntary reporting. For a review see Rich, 2008.
14. CCAR, 2006. San Francisco first city in U.S. to certify greenhouse gas emissions. Los Angeles: California Climate Action Registry.
15. This was originally slated for delivery in the fall of 2008, however at the end of the year it had not yet been unveiled.
16. This work is co-funded by the European Commission – see www.climate-compass.net/_project.html (last accessed 9 March 2009).
17. For more information on OECD work on cities and climate change, including links to this initiative from the Governance Directorate, please visit the website: www.oecd.org/env/cc/cities.
18. See also www.amap.no/acia. It is interesting to note that the report stopped short of having powerful policy recommendations in part because of reluctant state actors.