Chapter 4.

Enhancing environmental sustainability in the Valle de México

This chapter looks at the key environmental challenges of the Valle de México. It begins with an overview of the water, air, solid waste and land conservation problems that threaten the sustainability of the metropolitan zone. This is followed by an exploration of the governance obstacles that authorities face in addressing environmental challenges. It next considers the lack of a metropolitan vision, weak institutional arrangements, multiplicity of actors, sub-national governments' limited capacity and citizens' lack of awareness as the main barriers to environmental policy success. The main section considers some alternatives for tackling environmental concerns, as well as the need to use urban planning and a metropolitan resilience strategy to ensure policy coherence. It ends by making some recommendations for overcoming the governance obstacles to facilitate policy implementation and promote green growth.

Urban growth in the Valle de México, as in the other Mexican metropolitan zones, has largely been left to improvisation based on a reactive approach to urban policy challenges dictated by political priorities. A growing population, urban sprawl, lack of regional planning, corruption and mismanagement, as well as poor law enforcement and compliance, are just some of the causes of the environmental challenges that the Valle de México faces. Ensuring the competitiveness and attractiveness of the Valle de México while at the same time protecting the environment and natural resources is a difficult balance to achieve. The environment needs to be seen as an economic asset; the cleaner and greener the Metropolitan Zone of the Valle de México (Zona Metropolitana del Valle de México, ZMVM) is, the more opportunities it will have to attract investment and human capital to encourage economic growth and build resilience to global environmental change. Protecting the environment also has a direct impact on people's health and is a way of contributing to citizens' well-being.

This chapter looks at the environmental challenges and opportunities of the Valle de México. It begins with an overview of the main environmental problems of the metropolitan zone: water, air quality, waste management and conservation land. The discussion then turns to the main governance obstacles that prevent or limit an effective response to environmental concerns. Then the chapter makes some particular recommendations to address those environmental problems, in particular linking environment and urban policy. Finally, it discusses some governance alternatives to better tackle environmental problems and even boost the economic potential of the metropolitan zone. This chapter's overriding message is that to face the Valle de México's environmental problems, it is necessary to integrate environmental issues into urban planning. However, to achieve this aim, governance arrangements must be reinforced, as they provide a basis for that integration.

Key environmental problems: Water, air, solid waste and conservation land

The ZMVM faces critical environmental challenges that threaten its sustainability. The growing demand and low supply of drinking water, the poor air quality, the inefficient management of solid waste and the high risk to conservation land are the four main environmental threats that will be discussed in this section.

The Valle de México faces a dual water challenge

Water constitutes a dual challenge for the Valle de México. Authorities face a situation in which there is simultaneously too little and too much water. There is too little water for current and future demand for potable water to be met from local sources. At the same time, torrential rainfall during the rainy season results in frequent flooding that affects residents, houses and infrastructure. Moreover, growing water demand, overexploited local and neighbouring aquifers and basins, ageing infrastructure, lack of investment, artificial low tariffs and high operation costs, and the deterioration of water quality have taken the water system to the limits of its physical and financial operability.

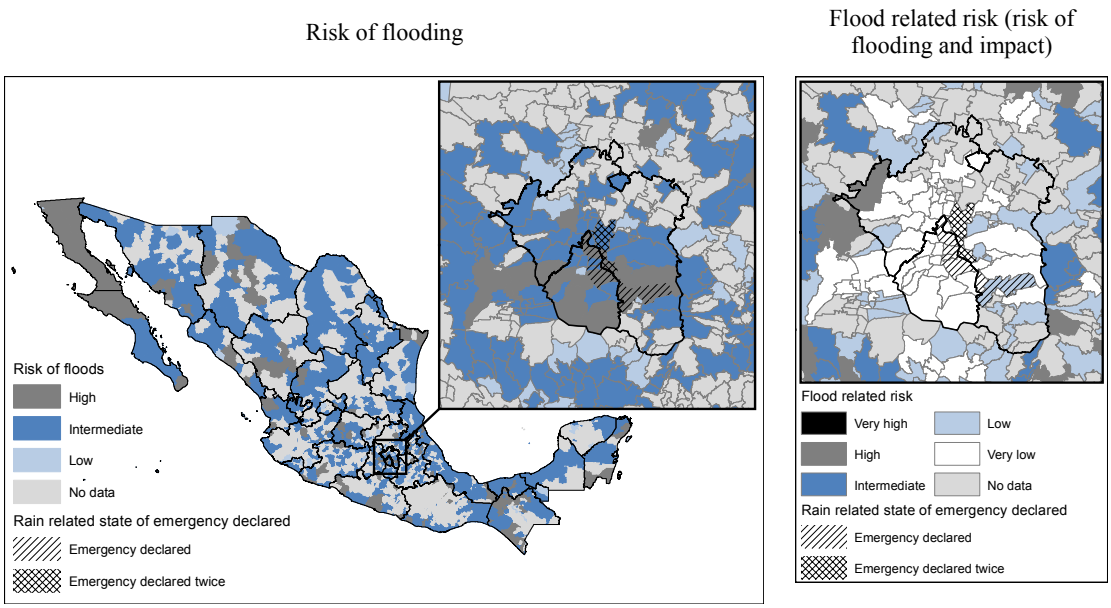
The metropolitan zone is liable to floods

Mexico City was founded on an island, surrounded by the Lake Texcoco, the largest among an interconnected chain of lakes within the Valle de México basin.[1] Starting in the early 17th century, efforts to drain the vast system of lakes continued until the 1970s and left only small remnants of the once vast expanse of surface water. Lake Texcoco covered almost 700 km² in 1521, but today only 70 km² of the area remain, of which only 15 km²

are covered by permanent bodies of water. The largest body of water is the artificially created lake "Nabor Carrillo", with a surface area of about 10 km², the sixth-largest lake in Mexico (CONAGUA, 2014a). Even with the tremendous effort of draining the basin, seasonal floods remain a concern. Between 1980 and 2011, rain-related flooding incidents occurred every year and caused severe traffic disruptions, damages to business, homes and residents.[2] During the rainy season, the metropolitan area experiences high-intensity rainfall in a short amount of time. A single storm can produce as much as 10% of the total average annual precipitation (see ANIS, 1995).

Flood risk in the Valle de México is high compared to most parts of the country. The southern parts of the metropolitan zone, along the area with the highest elevation, exhibit high risk levels. But the area at risk extends north beyond high-risk municipalities and *delegaciones* along the border between the Federal District and the State of Mexico. From 2010 to 2013, the *delegaciones* and municipalities along the northeastern border between the Federal District and the State of Mexico experienced several severe spells of rain that led to declarations of states of emergency (Figure 4.1, left panel). Beyond these very severe events, annual flooding regularly leads to disruptions in traffic flows and displacement of residents in these areas.

Figure 4.1. **Flood-related risks and flood-related states of emergency, 2010-13**



Note: This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: OECD calculations based on SEGOB (2015), *Atlas Nacional de Riesgos*, CENAPRED, Mexico, DF.

While the risk of floods is significant, the anticipated impact of damage is relatively low. Nearly all municipalities are considered in the lowest two categories when it comes to the expected impact of flooding (Figure 4.1, right panel). However, since drainage typically mixes rainwater with sewage, floods are associated with high health risk and severe impact on the liveability of local neighbourhoods. This is particularly relevant for neighbourhoods that are not connected to subterranean drainage but rather use open sewer canals. One such area is the municipality Valle de Chalco, located within the State of

Mexico and just east of the Federal District, where dwellings of poor residents have been flooded twice within two years by sewage from the local open-air canal (see Chelleri, Schuetze and Salvati, 2015). In 2010, heavy rain flooded the municipality, followed by flooding from a rupture in the canal in 2011. The direct cost can be sizeable. An estimate for the damages from the 2010 flood for six neighbourhoods[3] in the municipality was MXN 43.5 million (USD 3.4 million; see Díaz-Delgado et al., 2012).

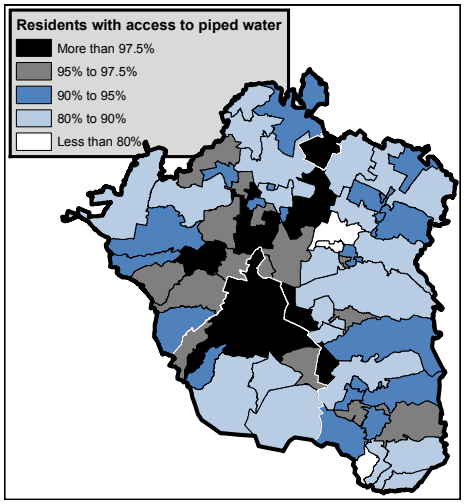
To address the recurring floods, Mexico's National Water Commission (Comisión Nacional del Agua, CONAGUA) invests heavily in expansion of the drainage network. Currently, two major tunnels are being constructed to support the existing network. The Eastern Drainage Tunnel, a new tunnel that runs through several municipalities in the State of Mexico along the border with the Federal District and into the state of Hidalgo, is the single largest expected investment in CONAGUA's current strategic projects (CONAGUA, 2015). The total estimated costs for the six-year project were MXN 37.5 billion (USD 2.8 billion) as of early 2015.[4] Once completed, the tunnel will drain both waste and rainwater. While such a dual use could be considered efficient, it also increases the cost of treating rainwater. Additionally, draining excess water means that opportunities for storing, treating and reusing rainwater inside the Valle de México are foregone. While current plans do not include an expansion of local storage, like the lake Nabor Carillo, the planned construction of the New Mexico City International Airport (Nuevo Aeropuerto Internacional de la Ciudad de México, NAICM) is likely to change this.

The NAICM is to be built in the State of Mexico in the former lakebed of Lake Texcoco. Located just north of the artificial lake Nabor Carillo and east of the urban centre of the Federal District, the airport will require substantial precautionary measures to guard against hydrological risks. In plans presented by the Ministry of Agrarian, Territorial and Urban Development (Secretaría de Desarollo Agrario, Territorial y Urbano, SEDATU), investments include the development of five lagoons in and around the area of the airport, which are planned to become a system of six lagoons until 2018, covering most of the former lakebed to the south of the new airport and substantially expanding the surface water storage capacity. The efforts to prepare the area around the new airport also include dredging works along the existing open-air sewage canals and the construction of a 3.6-kilometre drainage tunnel to alleviate pressure on the main sewage canals. This main canal is currently open-air, but is planned to be covered until 2018 along a 10.6-kilometre stretch passing the newly developed lagoons and the airport (SEDATU, 2014).

A growing scarcity of potable water

In the Valle de México, with most of the local surface water depleted, the main source of potable water is from wells that tap into the aquifers underneath the metropolitan area. But the rapid growth of the city, combined with a high per capita use of water and infrastructure-related water losses, has severely drained resources and overstrained the local aquifers (see Chapter 1). To cope with the demand, water supply has been supplemented by piped surface water from outside the Valle de México basin since the 1940s. Even with this effort, access to piped water remains uneven across the city. While on average, more than 95% of residents in the metropolitan zone had access to piped water, outside the metropolitan zone's densely populated urban centre, access to piped water remains far from universal (Figure 4.2). Thus water has become a national and sub-national priority established in the national and state development plans and a key element of the inclusive green growth goals of the national government.[5]

Figure 4.2. **Percentage of residents with access to piped water, 2010**



Note: This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: INEGI (2010a), *Censo de Población y Vivienda 2010*, Instituto Nacional de Estadística y Geografía, Aguascalientes, Mexico.

While the rainy season brings excessive amounts of rainwater, potable water is scarce and becoming scarcer. The local subterranean aquifers are under severe stress. Among the water concessions for the metropolitan area's main aquifers, 98% come from overexploited aquifers, i.e. aquifers in which abstractions exceed refill. The main aquifer underneath the Federal District, which accounts for nearly two-thirds of the concessions, is being drained rapidly (Table 4.1). Overexploitation has required wells to become deeper. They range up to a depth of 400 metres, where a depth of 70 metres was sufficient for older wells.[6] Due to the soil composition, extraction from deeper wells tends to be less efficient.

Table 4.1. **Overexploitation of the Valle de México's main aquifers**

Aquifer	Abstractions (concessions in m^3/s)	Recharge deficit (m^3/s)
ZM Ciudad de México	38.9	-22.6
Cuautitlán-Pachuca	10.5	-4.1
Texcoco	6.3	-1.6
Chalco-Amecameca	2.9	-0.5
Soltepec	0.6	1.1
Apan	0.3	1.9
Tecocomulco	0.0	0.8
Total	59.5	-25.0

Source: World Bank (2013), "Agua urbana en el Valle de México: ¿Un camino verde para mañana?", World Bank, Washington, DC, available at: www.agua.unam.mx/sacmex/assets/docs/AguaUrbana_ValleMexico.pdf.

The excessive abstraction from local aquifers has visible and significant effects on the urban landscape. Reduction in water in the clay soil that supports a large part of the city leads to densification of the soil and subsidence. The annual subsidence – the downward

shift – of the soil can reach up to 30 centimetres per year. The effect is particularly pronounced around the northeastern border between the Federal District and the State of Mexico, around the lakebed of the former Lake Texcoco.[3] The unsettled earth creates significant challenges for urban infrastructure. The "Grand Canal", a major drainage outlet for the Valle de México, used to rely solely on gravity for sewage disposal. Due to subsidence, the outflow was no longer sufficient, and in 2008, a pumping station was built to raise wastewater by 30 metres (see Jiménez, 2014). Differential subsidence creates strain on pipes and results in cracks and breaks in the infrastructure. The resulting leakage not only results in losses of potable water, but creates severe health hazards. Breaks in drainage pipes can cause contamination of surface and underground water sources, and combined with cracks in the potable water network, can also create cross-contamination. Cracks also reduce the potential pressure in pipes for potable water, further increasing the potential for contamination of drinking water (see Soto Montes de Oca, 2007).

To meet the high demand for potable water, an intricate water delivery system has been developed. The first part of today's system was built in the early 1940s and transported water from the Lerma basin, outside the Valle de México basin, to the metropolitan zone. In the 1970s, the Lerma system was complemented by a new system of long-distance water delivery, the "Cutzamala system". This system today is the main source of water delivered from outside the basin. The Cutzamala system pumps surface water across 127 kilometres from a set of 3 reservoirs and 4 dams. The water from the Cutzamala system is not only pumped across a long distance, but has to be elevated from a height of 1 600 metres above sea level to 2 700 metres.[8] The associated costs are significant. In 2013, 0.5% of the country's total electricity consumption was used by the Cutzamala system.

The transfers from external basins cover 22% of the total supply, while 68% are abstracted from local aquifers. Slightly more than half these abstractions are sustainable, i.e. balanced by refill. The vast majority of refill is natural infiltration. Surface water and treated wastewater account for the remaining 10% of total supply (Table 4.2). Nearly three-quarters of potable water is consumed in domestic use, with the industrial, commercial and service sector consuming the remaining fourth.[9]

Table 4.2. **Potable water by source in the Metropolitan Zone of the Valle de México**

	Local aquifer (sustainable)	Local aquifer (overexploitation)	Surface water	Transfer Lerma	Transfer Cutzamala	Treated wastewater	Total
Volume (m^3/s)	31.6	27.9	2.9	4.8	14.7	6.1	88
Percentage	36%	32%	3%	5%	17%	7%	100%

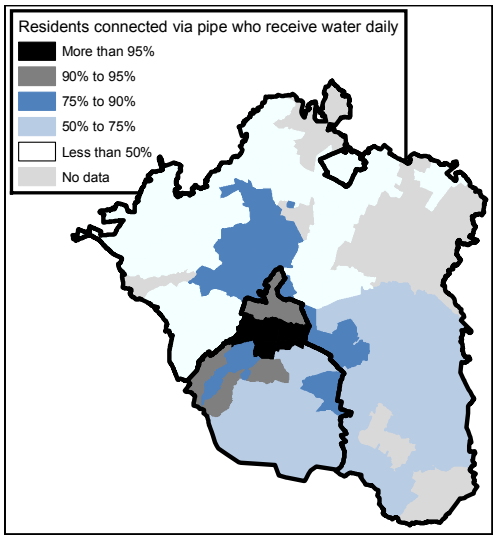
Source: World Bank (2013), "Agua urbana en el Valle de México: ¿Un camino verde para mañana?", World Bank, Washington, DC, available at: www.agua.unam.mx/sacmex/assets/docs/AguaUrbana_ValleMexico.pdf.

Despite the intense efforts in water delivery, supply does not reach all residents of the Valle de México. While nearly all households are connected to the water network, in some neighbourhoods, tapped water is only available at certain times or days (*tandeo*) and shortfalls have to be compensated by supplying residents via mobile water tanks. In the Federal District, 268 neighbourhoods (*colonias*) in 11 of the 16 *delegaciones* officially receive only limited piped service.[4] Survey evidence suggests that coverage outside the Federal District is even lower. Among residents who have access to piped

water in their home, less than 50% in the northern parts of the Valle de México and only 50-75% in the south receive water daily (Figure 4.3).

Water quality in the Valle de México is difficult to assess. Data on some indicators is available on a regular basis. For example, CONAGUA publishes information on the quality of water in the Cutzamala system. But this data is limited to colour and turbidity, acidity and hardness (pH scale, residual chlorine and $CaCo_3$ level), and taste and odour.[5] Information on contaminants is not provided, and neither is information on the quality of the water once it leaves the Cutzamala system and enters the local delivery networks. Aggregate measures for the presence of total organic matter and total biodegradable organic matter, as well as total suspended solids, are available annually for surface water in CONAGUA's statistical yearbook,[6] and show a low level of quality across most surface water in the Valle de México.[7] For groundwater, less information is available. Tests carried out in December 2007 and July 2008 found that only 35% and 47% of wells provided potable water that was norm compliant.[8] The remainder showed elevated bacteriological or chemical contamination. In 2008, only 4 out of 16 bodies of surface water had "acceptable" water quality or better, and the majority exhibited high levels of organic matter pollution.[9] Information on the quality of supplied water is limited. A recent study finds that pollution is most concentrated in the southern part of Valle de México, where local wells are contaminated by industrial production and past industrial activities, as well as intrusion from local sewage (see Soto Montes de Oca, 2007; and Jiménez, 2014).

Figure 4.3. **Percentage of residents with access to piped water who are supplied daily, 2010**



Note: 1. Adjacent municipalities/delegations have been aggregated to ensure that each spatial aggregate is based on a sample of at least 100 households.

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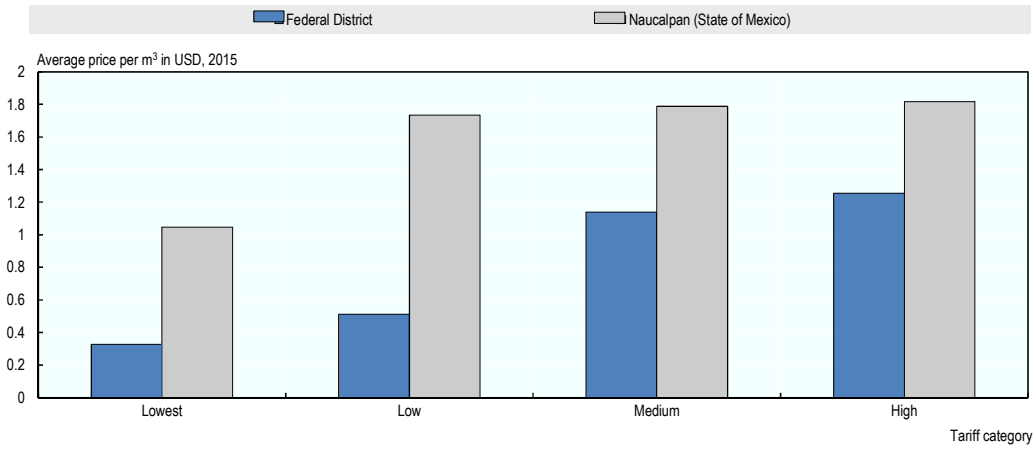
Source: OECD calculations based on INEGI (2010b), *Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH) 2010* [National Survey of Mexican Household Income and Expenditures], Instituto Nacional de Estadística y Geografía, Aguascalientes, Mexico.

Water tariffs are set locally and exhibit substantial variation. Tariffs have to be politically approved. For the Federal District, the legislative assembly approves changes in tariffs. In the State of Mexico, tariffs are set out for all municipalities (split into four groups) by the state, but the municipal councils have the option to grant general subsidies, surcharges or cancel fines.[16] In practice, this leads to a wide range of tariffs within the metropolitan area, which makes comparisons difficult. CONAGUA has established a national tariff register, which currently contains information up to 2012.[10] More recent tariffs tend to be available on the website of the providers the Water Utilities of Mexico City (Sistema de Aguas de la Ciudad de México, SACMEX) and the Water Commission of the State of México (Comisión del Agua del Estado de México, CAEM).

Tariffs typically distinguish between domestic and commercial use, with some allowing for mixed use, e.g. in the Federal District. They further apply different schedules, according to some measure of need within the neighbourhood. In the Federal District, for example, need is assessed based on a block-level development index that combines data on social marginalisation, income and property values. Comparability across tariffs is further limited by the inclusion or exclusion of fixed fees and drainage. Despite the challenge in creating comparable indices, studies tend to find that the price for water in the Federal District is very low by comparison with the municipalities across the metropolitan area. For example, compared to the municipality of Naucalpan, tariffs for households with about average levels of consumption are lower in all categories, with significant gaps for households that fall into the lowest two tariff categories (Figure 4.4).

Figure 4.4. **Average price per m^3 for 35 m^3 consumption in two months, 2015**



Note: Tariff categories for the Federal District/Naucalpan are *popular/popular con tandeo* (lowest); *baja/popular* (low); *media/medio* (medium); *alta/alto* (high). Tariffs are for 2015 and converted from MXN to USD using the average exchange rate for 2014. Tariffs in Naucalpan are reported in multiples of the daily minimum wage, which is converted using the minimum wage valid from April 2015 (MXN 70.10).

Source: Tariffs: Government of the Federal District (2014), "Decreto por el que se reforman, adicionan y derogan diversas disposiciones del Código Fiscal del Distrito Federal", *Gaceta Oficial Distrito Federal*, No. 2012(I), 22 December, available at: www.sacmex.df.gob.mx/sacmex/doc/3_atencion_a_usuarios/tarifas/6_tarifas172.pdf; Government of Naucalpan (2014), *Gaceta del Gobierno*, 18 December, p. 106, available at: http://caem.edomex.gob.mx/sites/caem.edomex.gob.mx/files/files/TramitesServicios/Tarifas2015/Naucalpan2015.pdf. Exchange rate: OECD (2015a), "PPPs and exchange rates", *OECD National Accounts Statistics* (database), http://dx.doi.org/10.1787/data-00004-en (accessed 30 June 2015); Minimum wage: CONASAMI (2015), "Tabla de salarios mínimos generales y profesionales por áreas geográficas", Comisión Nacional de los Salarios Mínimos, www.conasami.gob.mx/t_sal_mini_prof.html (accessed 7 April 2015).

The low rates do not set strong incentives to conserve water, especially in the Federal District, where 75% of consumers fall into the two lowest tariff categories.[11] As a result, water is heavily subsidised, both at the local and the national level. CONAGUA's budget includes about one-third of duties paid for water, SACMEX's budget to about two-thirds.[12] The remainder of CONAGUA's operating budget is covered nearly completely by fiscal contribution from the central government, SACMEX is subsidised by both the federal government and the government of the Federal District.[13]

The quality of air is not yet satisfactory

The Valle de México is the most polluted area in the country in terms of ozone, and the fourth for particulate matter PM_{10} (Centro Mario Molina, 2014). This represents a high cost to public health, and has a negative effect on the productivity, competitiveness and attractiveness of the metropolitan zone. The OECD's work on cities and climate change has observed that if their current pollution trends continue, even cities such as Chicago, Los Angeles, New York, Osaka, Paris, Seoul and Tokyo are at risk of losing economic attractiveness (OECD, 2010). In the international scene, Mexico is committed to reducing 30% carbon emissions by 2020 and by 40% by 2030 (a combined effect of reducing CO_2 emissions by 70% and greenhouse gas emissions by 36%) compared to the emission level in 2012.

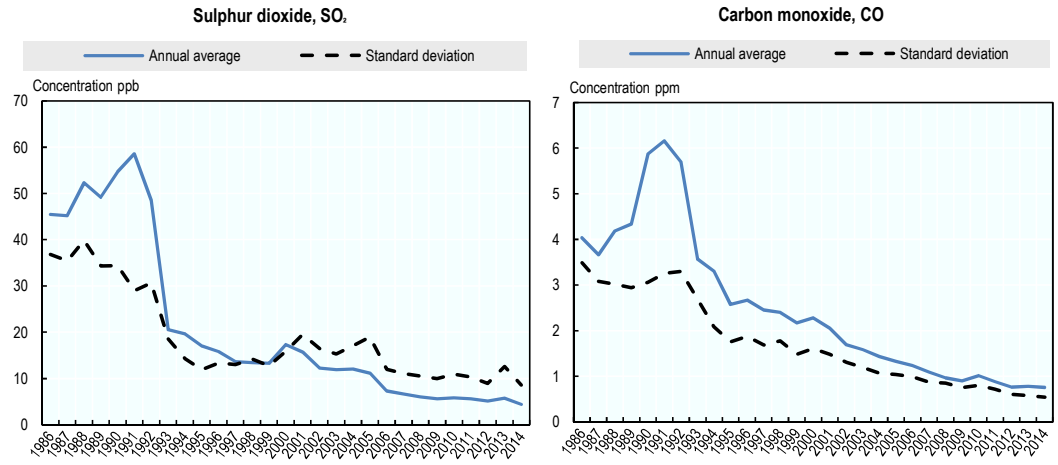
Encouraging results on SO_2 and CO are being obtained …

Federal and local authorities in the Valle de México have been relatively successful in improving the air quality in the metropolitan area. Over the last two decades, thanks to the implementation of four consecutive comprehensive programmes called ProAire (Box 4.1) there has been a dramatic reduction in local air pollution (Figure 4.5). Since 2003, the levels of SO_2 and CO have not been above the limit established by the Mexican Official Norm (NOM) of 0.130 ppm average per 24 hours and 11 ppm average per 8 hours respectively. The levels of lead (Pb) have been below the accepted limits since the component was removed from fuels in 1997. In spite of these achievements, local authorities acknowledge that additional efforts are needed to reduce the level of pollutants that are still beyond the national standards such as ozone and particulate matter. The measures adopted to improve air quality have been diverse, from closing the most polluting factories to banning cars in the metropolitan area one day per week through the *Hoy No Circula* programme ("No driving today"). Mexico City's government has introduced the Atmospheric Monitoring Network (*Red de Monitoreo Atmosférico*, SIMAT), which provides data for informed policy making and has led to the adoption of the Metropolitan Index of Air Quality, and the establishment of contingency and pre-contingency protocols.

Despite encouraging results and continuation in air quality improvement programmes, air quality is one of the main concerns of authorities and residents in the Valle de México. The effects of air pollution are being manifested in health effects that can range from a little irritation to acute sickness (decreased respiratory capacity, asthma, heart diseases or lung cancer) or even to premature death.[14] For example, the Mexican standard of ozone (O_3) – 0.11 ppm – is frequently exceeded, and its effects on human health are detected in the form of irritated eyes, persistent headaches and increased hyper-reactivity. Particulate matter and aerosols are other important pollutants caused by tobacco smoke, metal dust, metallic and fibrous particles, and exhaust fumes, which have long-term health effects such as cardiovascular disease, emphysema, cataracts, bronchitis, asthma and coughs. According to OECD calculations, the total number of deaths from ambient PM and ozone

pollution in Mexico increased from 17 954 in 2005 to 21 594 in 2010. Similarly, the years of life lost (YLL) from ambient air pollution increased from 377 739 to 448 436 in the same period. The same trend was reported in Australia, Canada, Chile, Japan, Korea and New Zealand for the same period, but 20 other OECD countries achieved a reduction in air pollution-related deaths (OECD, 2014).

Figure 4.5. **Emissions of sulphur dioxide (SO_2) and carbon monoxide (CO) in the Valle de México**



Source: Information provided by the Ministry of Environment of the Federal District (SEDEMA).

Box 4.1. **Improving air quality in the Valle de México: ProAire**

In 1990, the Mexican federal government, the Federal District and the State of Mexico presented the first Comprehensive Programme Against Air Pollution (PICCA) as a systematic plan to combat air pollution. It included restricting the circulation of private cars on certain days, depending on registration plate. During the period the second programme, ProAire II 1995-2000, was in force, the Metropolitan Environmental Commission was created to co-ordinate the actions of the federal and the two local governments in the Valle de México. During ProAire III 2002-2010, the Metrobús and the shared bike programme ECOBICI were introduced. Emission reductions over this period were estimated at 5 078 tonnes/year of PM_{10}, 506 tonnes/year of SO_2 and 817 132 tonnes/year of CO. In the Valle de México, the implementation of ProAire has made significant progress in reducing air pollution. It is estimated that between 1997 and 2005, 1 928 deaths were averted due to the reductions of PM_{10} concentrations and 794 due to reduction in ozone concentrations. ProAire has also been reinforced by the implementation and constant updating of Mexico City's Atmospheric Monitoring System (SIMAT), which has made it possible to monitor air quality from 40 different points in the metropolitan area. It includes a laboratory for the physico-chemical analysis of samples and a centre for the processing and diffusion of air quality data.

ProAire IV 2011-2020 is the main guideline for establishing an eco-systemic approach in the management of the air quality in the Valle de México. It has 81 measures and 116 actions across 8 strategic themes to further improve air quality and reduce greenhouse gas emissions by 2020. The eight strategic themes are: reduction of energy consumption; cleaner and more efficient energy across all sectors; promoting public transport and regulating fuel consumption; technology shift and controlling emissions; environmental education; creating a sustainability culture and citizen participation; green areas and reforestation; and institutional capacity building and scientific research. The expected results include 490 000 tonnes of fewer emissions of "criteria" pollutants: hydrocarbons, carbon monoxide, sulphur oxides, nitrogen oxides, PM_{10} and $PM_{2.5}$ and ozone; 5 000 tonnes of toxic pollutants; and 5.5 million tonnes of greenhouse gases. Mexico City's ProAire programme has been awarded the C40 & Siemens Climate Leadership Award in the Air Quality category for its results in reducing local air pollution, as well as CO_2 emissions.

Box 4.1. **Improving air quality in the Valle de México: ProAire** (*continued*)

One of the main problems of dealing with air pollution is that the Mexican standards are not fully in line with international standards established by the World Health Organization (WHO). In some cases, the discrepancy is due to the fact that the Mexican standards were formulated before the international standards were set.

Table 4.3. **Mexican and WHO standards for measuring air quality**

Pollutant	Mexican standard	WHO standards
Particulate matter $PM_{2.5}$	**NOM-025-SSA1-1993** 15 μg/m³ annual mean 65 μg/m³ 24-hour mean	10μg/m³ annual mean 25 μg/m³ 24-hour mean
Particulate matter PM_{10}	**NOM-025-SSA1-1993** 50 μg/m³ annual mean 120 μg/m³ 24-hour mean	20 μg/m³ annual mean 50 μg/m³ 24-hour mean
Ozone (O_3)	**NOM-020-SSA1-1993** 0.110 ppm 1-hour average not to be exceeded more than once a year 0.080 ppm 8-hour average – Fifth maximum taken over a period of one year	100 μg/m³ 8-hour mean
Nitrogen dioxide (NO_2)	**NOM-023-SSA1-1993** 021 ppm 1-hour mean – not to be exceeded once per year	40 μg/m³ annual mean 200 μg/m³ 1-hour mean
Sulfur dioxide (SO_2)	**NOM-022-SSA-1993** 0.130 ppm 24-hour mean – not to be exceeded once per year 0.030 ppm annual mean	20 μg/m³ 24-hour mean 500 μg/m³ 10-minute mean

Sources: Government of the State of Mexico (2011), *Programa para Mejorar la Calidad del Aire de la Zona Metropolitana del Valle de México 2011-2020*, Government of the State of Mexico, SEMARNAT, Secretaría de Salud, SEDEMA, www.sedema.df.gob.mx/flippingbook/proaire2011-2020 (accessed 15 August 2015); OECD (2013a), *OECD Environmental Performance Reviews: Mexico 2013*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264180109-en; C40 Siemens (2014), "City Climate Leadership Awards: Mexico City climate close-up", available at: www.siemens.com/press/pool/de/events/2014/infrastructure-cities/2014-06-CCLA/mexico-climate-close-up.pdf; Background Questionnaire for the OECD review answered by Mexico City's Ministry of Environment; WHO (2005), "WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide, Global update 2005, Summary of risk assessment", World Health Orgnization, Geneva, available at: http://apps.who.int/iris/bitstream/10665/69477/1/WHO_SDE_PHE_OEH_06.02_eng.pdf; Secretaría de Salud (2002), *Modificación a la Norma Oficial Mexicana* NOM-020-SSA1-1993, www.salud.gob.mx/unidades/cdi/nom/m020ssa13.html (accessed 15 August 2015).

Reducing the levels of emissions in the ZMVM is considered a shared responsibility among the Federal District, the State of Mexico and the federal government. Table 4.4 shows that most of the pollutants originate in the municipalities in the State of Mexico where the majority of the sources of emissions are located, including industries (manufacture) and private vehicles. The responsibility of the federal government is to regulate chemical industry, metals production, the generation of electric energy, freight transport vehicles and inter-state bus services, etc.

… but the lack of an efficient transport strategy undermines progress on air quality improvement

The Valle de México currently has no efficient transport solution between most of the municipalities in the State of Mexico and Mexico City. Urban sprawl, long commuting distances and the increase in the number and use of private vehicles are just part of the environmental challenge. The underground system in the State of Mexico is still limited, and most commuting is done in low-capacity and polluting buses (*microbúses*). Private vehicles represent 78% of the vehicle fleet in the ZMVM, but only cover one-third of the

Table 4.4. **Inventory of emissions in the Valle de México by jurisdiction, 2012**

Jurisdiction	Emission (t/year)										
	PM_{10}	$PM_{2.5}$	SO_2	CO	NO_X	COT	VOCs	NH_3	Toxics	CN	CO_2eq.
Federal District	6 552	2 185	217	594 116	79 287	232 949	199 483	16 210	75 001	293	13 401 215
State of Mexico	23 335	4 749	1 052	944 674	117 734	536 841	314 436	27 799	97 489	597	24 576 236
Federal	4 790	2 517	3 598	67 258	42 111	125 579	118 829	183	23 325	1 226	11 525 559
Total	34 677	9 451	4 867	1 606 048	239 132	895 369	632 748	44 192	195 815	2 116	49 503 010
	Emissions (%)										
Federal District	19	23	4	37	33	26	31	37	38	14	27
State of Mexico	67	50	22	59	49	60	50	63	50	28	50
Federal	14	27	74	4	18	14	19	N/S	12	58	23
Total	100	100	100	100	100	100	100	100	100	100	100

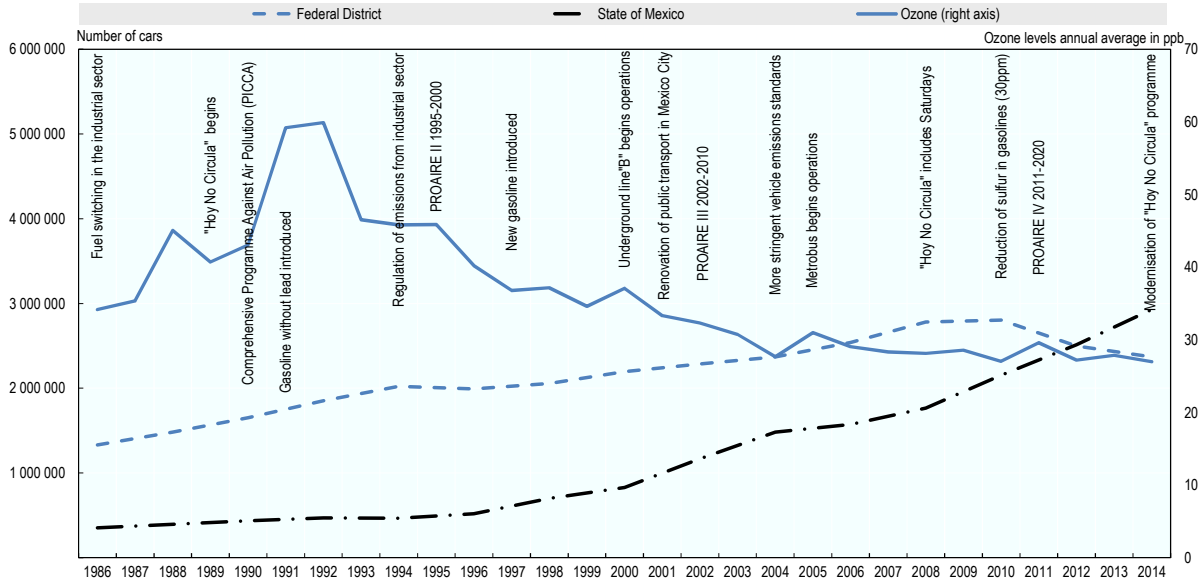
Note: N/S = Not significant.PM_{10} and $PM_{2.5}$ (particulate matter); SO_2 (sulphur dioxide); CO (carbob monoxide); NO_X (mono-nitrogen oxides); COT (total organic compounds); VOCs (volatile organic compounds); NH_3 (ammonia); CN (black carbon); CO_2 eq (carbon dioxide equivalente)

Source: Government of the Federal District (2012), *Inventario de Emisiones Contaminantes y de Efecto Invernadero, Zona Metropolitana del Valle de México*, Secretaría del Medio Ambiente.

mobility needs. The public transport fleet represents 8% of the vehicles in the ZMVM and covers two-thirds of the transport needs. Figure 4.6 shows that the number of privatevehicles is increasing, mostly in the State of Mexico, whereas the levels of ozone, although decreasing, are not entirely satisfactory. According to Mexico City authorities, the number of cars rose from 2 million in 1990 to 5 million in 2012, but reports from the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía, INEGI) suggest that the number is even higher, at approximately 6.8 million.[22] However, the implementation of the ProAire programme, improvements in gasoline fuels and the adoption of greener technologies for the vehicle fleet may have contributed to a decrease in levels of ozone.

Figure 4.6. **Evolution of car ownership levels and ozone emissions in the Metropolitan Zone of the Valle de México**

Main environmental initiatives



Source: Information provided by the Ministry of Environment of the Federal District (SEDEMA).

The increasing number of cars, the inefficient traffic signal system and the road layout have reduced the average vehicle travel speed of cars, which is currently 17 km/h. Mexico City authorities consider that there is a risk this may drop in the coming years, which could led to higher levels of pollutants such as volatile organic compounds (VOCs), CO and NOx. A large majority of car trips transport only one or two passengers (SEDEMA, 2012). The vehicular fleet that uses fossil fuels represents 95% of the total fleet and consumes 21 million litres of fuel every day. In addition, the inadequate zoning of some businesses, which lack parking spaces for customers and providers, and the use of part of the road lanes by informal businesses (*comerciantes ambulantes*) obstruct the traffic, causing congestion, low speeds and higher emission levels. All these facts underline the urgent need for better managing private vehicles in order to improve air quality in the ZMVM.

Another critical problem is freight transport, which relies on highly polluting diesel fuels, which requires stricter regulation. No local government has competency in this area, as it is regulated by the federal government. The only area over which local

governments have discretion is on regulating when trucks are allowed to circulate. Freight transport represents 14% of the transport fleet (700 000 freight vehicles are registered in the ZMVM), most of them highly polluting. Monitoring this sector is highly complicated and expensive (SEDEMA, 2012).

An inadequate management of solid waste is threatening land, water and air quality

The Valle de México lacks a comprehensive solid waste management system. One of the main problems is that even the existence of landfills does not guarantee an adequate treatment of waste. A number of studies conducted by Mexican institutions report an insufficient and inadequate infrastructure for managing solid waste (Barreda Marín, 2009). Mexico City produces 12 800 tonnes of solid waste every day (an average of 1.5 kg per capita). Only between 3.9% and 6.7% of the waste that enters into the selection plants is recuperated, and the rest is deposited in landfills. Managing solid waste costs MXN 3 billion yearly (USD 185 million approximately). Mexico City has 13 transfer stations to select, store and concentrate solid waste. It also has two selection plants to separate waste that can be recycled. There are six composting plants that reuse organic waste. Solid waste that cannot be treated by any biological or chemical process is sent to final disposal sites in the State of Mexico and in Morelos (7 613 tonnes per day). From waste that is received at the transfer plants, 56% is sent to final disposal sites, 25% goes to composting plants, 19% to selection plants and the rest to the cement industry. Mexico City's government has issued an integral plan for the management of solid waste, with the aim of generating energy based on organic waste by 2018. The *Basura Cero* ("Zero Rubbish") programme is a valuable effort to minimise waste generation, maximise recycling and improve waste collection, but it should be extended to the entire metropolitan zone. The State of Mexico has ten landfills where half of the solid urban waste is deposited. The rest is sent to 37 controlled disposal sites and 52 non-controlled sites or garbage dump opencast sites. In the ZMVM, there are 22 non-controlled dump sites where any kind of waste is disposed of without restrictions (Barreda Marín, 2010). According to the Ministry of Environment of the State of Mexico, one-fifth of the generated waste is not collected and is left in clandestine dump sites.

The problem of waste in the ZMVM is not just the amount produced but also the lack of a preventive plan and of available spaces for its concentration and final disposal. This has led to the proliferation of non-controlled dump sites or clandestine sites in many areas of the Valle de México.[23] This situation is affecting the recharge of aquifers, leading to loss of habitat and biodiversity, increasing the emissions of greenhouse gases (GHG), generation of vermin, loss in the quality and productivity of land, and the obstruction of waterways. Since 50% of the dump sites are opencast, an uncontrolled production of biogas and leachate is damaging the environment and causing health problems. The production of leachate is polluting groundwater, as many landfills, principally the uncontrolled ones, are not properly prepared to store solid waste, and many are located in conservation land or in areas close to the aquifers in the State of Mexico. In some cases, mine shafts are used as dump sites, and many are located close to watersheds. Opencast dump sites close to sewage canals are potential generators of GHG and the proliferation of vermin, increasing the potential for disease.

One of the problems in analysing waste management is the lack of good data on the generation, disposal and composition of waste at national, state and municipal level (Barreda Marín, 2009). Data are mostly dated and incomplete. Several clandestine dump sites of urban solid waste have neither been inventoried nor monitored by any authority.

There are no records of recycled materials in the State of Mexico and most of the work in the metropolitan zone is conducted by informal workers (*pepenadores*). The sewage canals of the ZMVM, located mainly in the State of Mexico, also contain liquids produced by the decomposition of the urban solid waste deposited in them and are a source of GHG, but they are not included in the garbage-related registry. National urban solid waste data are presented by state or regions (Centre, North, South, Northern Border and Federal District) and on occasion based on the size of population centres. However, none of these criteria is sufficient to quantify the generation of waste in the ZMVM. Only about half of the municipalities of the State of Mexico are part of the ZMVM, others are part of the Metropolitan Zone of the Valle de Toluca, and the rest are semi-urban or rural communities with very different characteristics. The data thus have a very low level of certitude. Grouping the State of Mexico with a large number of other entities makes it impossible to analyse waste management at the metropolitan level.

Lack of planning is putting conservation land at risk

Conservation land is of great importance to the sustainability of the metropolitan zone, affecting all three major environmental problems (water, air and solid waste). According to the 2013-2018 Development Programme of the Federal District, 59% of the city's territory is conservation land, located mainly in the south and southwest (see Chapter 1). The conservation land is critical for recharging the aquifers, improving air quality, protecting biodiversity, regulating weather and providing recreational opportunities, which in turn promotes eco-tourism. Nonetheless, the lack of urban planning, urban sprawl, deforestation, fragmentation of the forest, irregular human settlements and the pollution of the soil through residual waters and uncontrolled, inadequate landfills are putting conservation land at risk.

To address the problem, Mexico City's government has implemented ecological management and urban development programmes to regulate the use of land and productive activities, both to prevent irregular settlements and protect the biodiversity and ecosystems (e.g. in the lake area of Xochimilco). Authorities have been identifying areas in conservation land with a particularly high potential for the generation of environmental services and are negotiating with the private owners on a compensation scheme to protect the land and develop sustainable environmental services. Communication strategies on the environmental and urban regulation aimed at raising awareness of the importance of the conservation land for the sustainability of the city are being adopted. Some efforts are also being made to train environmental inspectors and officials to improve the implementation of regulations. The State of Mexico has an initiative to protect forest lands, under which the government gives a type of subsidy to land owners as an incentive not to build on the land. However, this scheme applies mainly to municipalities that are not part of the ZMVM. The preservation of the conservation land will not only require legal reinforcement, but adopting the technical instruments, such as land-use planning.

Governance obstacles for addressing environmental problems

The Mexican authorities are working to address the environmental challenges in the Valle de México, but much remains to be done. Interviews conducted for this review suggested that the origin of the environmental problems is largely governance-related. How effective organisational arrangements and how efficient policy instruments are to address environmental challenges seem to be the primary concern of national and local policy makers and academics. Current governance arrangements are creating bottlenecks

that slow down progress and prevent a comprehensive response to environmental challenges.

A "megalopolitan" dimension to improve governance for a better environment

In 2013, to confront the socio-economic and environmental challenges in Mexico's Central Region and based on the positive experience of the former Metropolitan Environmental Commission (Comisión Ambiental Metropolitana, CAM), Mexican federal and local authorities created the Environmental Commission for the Megalopolis (Comisión Ambiental para la Megalópolis, CAMe). It includes the six central entities: Mexico, Hidalgo, Morelos, Puebla, Tlaxcala and the Federal District.[24] The CAMe is designed to be the environmental governance platform to support policies, programmes and actions that encourage sustainability and green growth in the Central Region of the country. It allows policy makers to meet and discuss environmental issues on a regular basis. The commission has neither implementation nor enforcement responsibilities. It does not intend to replace local or municipal governments in their environmental responsibilities, but to support them by facilitating understanding, co-operation and co-ordination in areas of common interest, and to provide evidence for informed policy- and decision making. One recent example of environmental protection at megalopolitan level is the harmonisation of standards for vehicle environmental assessment and the extension of the *Hoy No Circula* programme to the six entities of the megalopolis. According to Mexican authorities, these measures are expected to contribute to a reduction of environmental pollution of 11% every year.[25] Moreover, policy makers have realised that reaching agreement on the macro level is not a problem but the challenge is to work on details for implementing the decisions agreed upon. Governments will need to be willing to pay the political costs of implementing the decisions taken by the CAMe.

Box 4.2. **The Environmental Commission for the Megalopolis (CAMe)**

Created in 2013, the Environmental Commission for the Megalopolis (CAMe), which replaces the Metropolitan Environment Commission, aims to: establish a regional environmental policy framework; design and implement environmental projects with an integrated regional vision; encourage informed decision making and build consensus; provide technical support and training to the different entities of the megalopolis; and conduct research. The territorial demarcation for the CAMe includes the 16 *delegaciones* of the Federal District, and some municipalities from the states of Hidalgo (29), Mexico (79), Morelos (34), Puebla (22) and Tlaxcala (61). They constitute the Central Region of the country. The CAMe intends to provide an integral approach to the megalopolitan region for diagnostics, analysis and actions on environmental protection. It also aims to create synergies to tackle common problems and facilitate transversal decision making. Moreover, the CAMe intends to create a critical mass by facilitating citizens' participation in the discussion of environmental problems.

The commission has an Organ of Government (*Órgano de Gobierno*), as the highest decision-making body, composed of the governors of the states of Mexico, Hidalgo, Puebla, Tlaxcala and Morelos; the Mayor of Mexico City; and the federal Minister of Environment and Natural Resources. It meets every two months. The Advisory Scientific Committee (Comité Científico Asesor) is a body for technical consultation composed of 12 members of academia, think-tanks and non-governmental organisations. Its membership is renewed every two years and works on an honorary basis. The Executive Co-ordination (*Coordinación Ejecutiva*) body acts as the secretariat of the commission.

Sources: CAMe (2014), *La CAMe a 6 meses de su creación*, Coordinación Ejecutiva de la Comisión Ambiental de la Megalópolis, 4 April; Secretaría del Medio Ambiente y Recursos Naturales (2013), "Convenio de coordinación por el que se crea la Comisión Ambiental de la Megalópolis", *Diario Oficial de la Federación*, 3 October.

A lack of a shared vision and the particularities of the political system constitute a bottleneck

The lack of a widely shared environmental vision and strategy to tackle urban challenges seems to be an obstacle to a co-ordinated metropolitan response to environmental challenges. Interviews conducted for this review did not show strong evidence that every organisation has the same vision or that municipal-level governments have the same level of commitment to protecting the environment. The federal and state governments acknowledge the importance of working on climate change and environmental sustainability, but responses have been largely fragmented and, on some occasions, divergent. Moreover, although the Federal District and the State of Mexico have environmental and climate change policies, plans and programmes, there is little evidence that the two entities work as a team in the Valle de México. For example, whereas Mexico City has a mobility strategy that covers all its territory, the State of Mexico has only a mobility strategy for the Metropolitan Zone of the Valle de Toluca, where the state's capital is located. Furthermore, while Mexico City's Climate Action Programme emphasises mass transport initiatives, the State of Mexico is basing its strategy on building more motorways and roads to reduce traffic congestion, which is totally at odds with its Climate Action Programme.[26]

The different entities in the Valle de México appear to be moving at different speeds, and sometimes in different directions, due to policy fragmentation and uncoordinated actions. It is particularly revealing that Mexico City has made more progress on environmental sustainability and climate change mitigation and is now working on a resilience strategy, whereas the State of Mexico and Hidalgo are lagging behind. The State of Mexico has just begun work on a risk atlas for climate change, a first step towards resilience, but no systematic efforts have been made towards building a resilience strategy or moving in that direction. ProAire seems to be one of the few examples where co-ordinated action has taken place and where positive results have been achieved. Similarly, there is no concrete evidence that environmental policies are aligned with the interests or the needs of private sector stakeholders. Not all local governments seem to be willing to pay the political costs policies may entail. For instance, the CAMe is considering a proposal to harmonise the car-ownership tax. It is up to every state-level government whether it will collect the tax, and some states in the megalopolitan area have refrained from collecting it for political reasons. Adding an extra day per week without a car has reduced the popularity of the state governments that took this decision.

It is unclear to what extent municipal-level governments are active in environmental protection and climate change mitigation and adaptation. Some municipalities are taking steps to protect the environment and encourage the use of non-motorised transport, such as bicycles, but this does not seem to be the case across all municipalities and *delegaciones* in the ZMVM. Where such initiatives exist, they do not appear to be part of strategic urban planning, but one-off projects.

The political system is not conducive to co-ordination and co-operation. At the municipal level, neighbouring municipalities of different states do not co-ordinate their actions, as they need the approval and support of their state governments. The problem is exacerbated when those municipal-level governments belong to different political parties, which leads to no communication and co-ordination at all. Co-ordination for environmental protection in the metropolitan zone and the megalopolitan region seems to be easier at state level. The creation of the CAMe, under the leadership of the federal government, has brought together state governments from different political parties.

Nonetheless, this level of co-operation does not seem to be replicated at municipal level. A lack of political continuity also complicates co-operation, as there is no guarantee that the next administration will have the same disposition to co-operate. An environmental strategy at metropolitan level underpinned not only by political will but, more importantly, a political and social mandate, would be preferable. The reported lack of continuity in state programmes started by previous administrations, in particular in the State of Mexico, is a major difficulty for implementation, evaluation and adaptation of the programmes.

The CAMe's weak institutional arrangements …

The creation of the CAMe to replace the CAM and cover a larger territory has somehow weakened effective governance structures. The reason for this may be the limited institutional capacity of the CAMe, its lack of adequate funding and the fact that it has no enforcement capacity. The other factor is that the CAMe will have to generate agreements and understanding among six local governments and the federal government, something that will require strong efforts and resources beyond its capacity. Although the commission is still in its infancy, it needs to show it has the political and technical muscle to lead and implement the strategic orientations agreed by governors and the federal government.

In addition, the CAMe presents two further weaknesses that may compromise its effectiveness. First, the capacity at the Executive Co-ordination is insufficient. At least until 2015, there were only 11 full-time officials appointed to the Executive Co-ordination, although the staffing level is not expected to exceed 30 officials. So far, most of the technical work has been done by external consultants financed by donations from international co-operation agencies. Second, the financing of the commission is progressing slowly. The Megalopolitan Environmental Trust needs to be approved to act as the financial instrument of the CAMe. In February 2014, the members of the commission agreed to give MXN 5.00 to the trust for every environmental vehicle inspection carried out in their territory. The funds will be used to meet the objectives of the CAMe and support the operation and administration of the Executive Co-ordination. Federal funds are also used for the financing of the commission.

… and the multiplicity of actors complicate co-ordination

At the federal level, the Ministry of Environment and Natural Resources (Secretaría del Medio Ambiente y Recursos Naturales, SEMARNAT) combines policy making, regulation and implementation functions, while some bodies, called *desconcentrados*, also have policy-making functions.[27] The environment sector at federal level, led by SEMARNAT, includes decentralised bodies but also *desconcentrados*. These are autonomous in decision making but controlled by SEMARNAT in administrative issues such as human resources and finances. They include the National Water Commission (CONAGUA), the National Protected Areas Commission (Comisión Nacional de Areas Naturales Protegidas, CONANP), the National Ecology and Climate Change Institute (Instituto Nacional de Ecología y Cambio Climático, INECC) and the Federal Attorney for Environmental Protection (Procuraduría Federal de Protección al Ambiente, PROFEPA). Decentralised bodies exist as legal entities with their own budgets, such as the Mexican Institute of Water Technology (Instituto Mexicano de Tecnología del Agua, IMTA) and the National Forestry Commission (Comisión Nacional Forestal, CONAFOR). Most of the financial resources for the environment sector go to water and

forests. CONAGUA accounts for nearly three-quarters of SEMARNAT's budget, and CONAFOR a further 13%.

In the water sector, in the Federal District, the provision among the 16 *delegaciones* is pooled in a single provider, the Water Utilities of Mexico City (SACMEX). Municipalities in the State of Mexico provide services mostly themselves, with the Water Commission of the State of Mexico (CAEM) having responsibilities transferred by some smaller municipalities. The CAEM co-ordinates action between municipalities and the federal government to improve water management, water and sanitation services and it provides technical assistance and develops infrastructure. In practice, all bodies of water are administered centrally by CONAGUA, which provides major infrastructure and water-related permits. Exploitation of water sources is permitted through concessions for the private sector and allocations to states and municipalities. All abstraction rights are recorded in a Public Registry of Water Rights and typically last for several decades, with the option of renewal. Concessions are tradable, and sales need to be registered. The recorded number of trades is likely to be an underestimate, as informal, i.e. unrecorded, lease agreements for concessions occur. For Mexico, estimates suggest that more than 15% of the population uses water without a permit or concession (see OECD, 2013d).

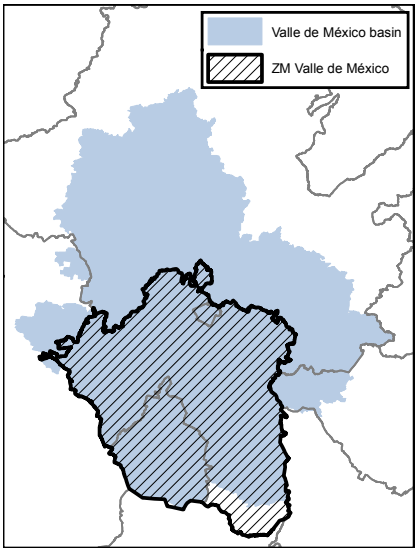
Moreover, the 1992 National Water Law established basin councils as co-ordinating and consultative authorities that bring representatives from CONAGUA, the federal states, municipal commissions and civil society together. In an effort to improve water governance, in 2004, an amendment to the law established 13 watershed organisations as autonomous structures with technical, administrative and legal prerogatives, acting as CONAGUA implementing agencies. In parallel, basin councils were to remain the main institutions under federal authority for water management at the basin level (see OECD, 2013d). Commissions and committees that focus on specific local areas or topics support the work of the basin councils and organisations. The ZMVM falls into the Valle de México basin. The basin and its organisation and council cover a significantly wider area in the states of Hidalgo and Mexico and include parts of Tlaxcala (Figure 4.7, left panel). The basin combines two hydrological zones, the Valle de México area, consisting mainly of the metropolitan zone, and the Tula Valley in the north (Figure 4.7, right panel). The basin council combines representatives from the Federal District (SACMEX), the three states, the CAEM and CONAGUA via the Valle de México Basin Organisation (Organismo de la Cuenca de Aguas del Valle de México).[28] At least for the provision of potable water, the main decisions are taken at the local level, with little co-ordination across municipal boundaries. Collaboration in flood prevention appears to be stronger and well-established.

The environmental responsibilities of local governments are specified in the General Law on Environmental Protection (Ley General de Equilibrio Ecológico y la Protección al Ambiente, LGEEPA). In the Federal District, the Ministry of Environment (Secretaría de Medio Ambiente del Distrito Federal, SEDEMA) is responsible for the design and implementation of an environment protection strategy, and the promotion of a sustainable urban environment. It focuses on six main areas: air quality and climate change, sustainable mobility, conservation land and biodiversity, green urban infrastructure, provision and water quality, and environmental education and communication. The State of Mexico's Ministry of Environment (Secretaría del Medio Ambiente del Estado de México, SMA) is also in charge of the formulation, implementation and evaluation of the environment strategy, and in particular the State Programme for Environment Protection and the State Climate Action Programme. It is responsible for co-ordinating the state environment strategy with the municipalities, including its 59 municipalities that are part

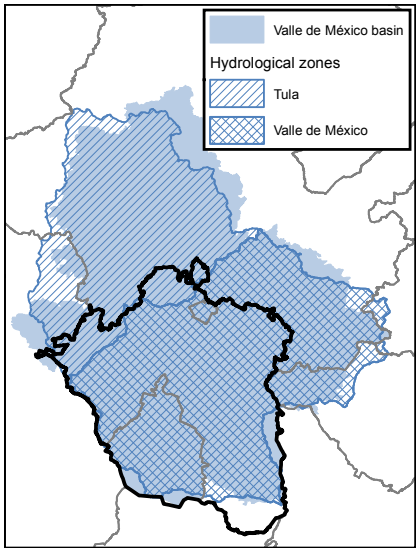
of the ZMVM. The state government has also created the Institute for Climate Change to co-ordinate and support work in this area.

Figure 4.7. **Valle de México basin and administration**

Valle de México: Basin and metropolitan zone



Hydrological zones in the Valle de México river basin



Note: This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Sources: CONAGUA (2007a), "Regiones hidrológicas administrativa (organismos de cuenca)", Comisión Nacional del Agua, www.conabio.gob.mx/informacion/metadata/gis/rha250kgw.xml?_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent=no (accessed 28 May 2015); CONAGUA (2007b), "Subregiones hidrológicas, escala 1:250 000. República Mexicana", Subdirección General Técnica, Comisión Nacional del Agua, www.conabio.gob.mx/informacion/metadata/gis/sbrh250kgw.xml?_xsl=/db/metadata/xsl/fgdc_html.xsl&_indent=no (accessed 28 May 2015).

The implementation of environmental policies is beyond sub-national governments' capacity

Across the Valle de México there seems to be insufficient technical expertise, infrastructure and money to design, implement and follow up sustainable development policies, particularly at municipal level. Financing environmental strategies such as those included in the climate action programmes constitutes a major barrier to implementation. The federal budget continues to be the main source of funding for environmental expenditure (see Chapter 5).

Municipal-level governments lack the technical and institutional capacity to implement sustainability strategies, in particular those regarding climate change. Interviews with officials from several municipalities and authorities in the State of Mexico suggested that there is weak regulation of activities such as energy, transport and solid waste management, whereas the use of solar energies is not encouraged. The problem is aggravated by weak enforcement of environmental law on the part of the state and municipal authorities, which results in low levels of compliance. Moreover, municipal-level governments do not appear to have the necessary personnel with the

competencies, skills and experience to design and implement urban planning, zoning and environmental protection strategies.

The drawbacks of the waste management system epitomise the lack of capacity at municipal level. There is a large difference in the regulation, operation and inspection capacity for waste management between the Federal District and the State of Mexico. In the Federal District, the responsibility for ensuring collection and management of waste corresponds to the central government through the Ministry of Public Works (Secretaría de Obras y Servicios del Distrito Federal, SOBSE), whereas in the State of Mexico every municipality is responsible for the management of waste, and the state government sets guidelines for the integral management of waste. The problem is that the majority of municipalities do not have the infrastructure to collect and dispose of waste. The vehicles that collect waste, for example, are obsolete and do not allow the separation of waste (Gutiérrez, 2014). Insufficient personnel to conduct inspections, supervise the operation of landfills and ensure compliance with the norms is also an issue. Surveillance of the landfills is limited, to make sure that no other type of toxic, biological or infectious waste is deposited with urban solid waste, which can change its composition. Moreover, the operation of final disposal sites (landfills and controlled sites) is in many cases the responsibility of private enterprises that have obtained a concession. This situation often leads to discretional management of the registry of the quantity, composition and treatment of waste (Barreda Marín, 2009). Similarly, in the water sector, municipalities are responsible for the provision of drinking water, drainage, sewage and water treatment (under Article 115 of the Constitution). Some municipalities, however, struggle to provide these services for lack of funding and technical capacity.

The lack of systematic follow-up and measurement of outcomes of the different environmental protection strategies is an obstacle to assessment of progress and impact. The OECD (2013a) *Environmental Performance Review of Mexico* concluded that monitoring, reporting and evaluation of environment programmes was increasing but was not yet focused enough on outcomes. This also applies for the Valle de México. Reporting takes place through activity reports, implementation reports and annual working programmes' implementation reports in both the Federal District and the State of Mexico. Some evaluations are already providing useful feedback. The evaluation of the ProAire programme suggests that air-quality standards could be more stringent, to reap additional health benefits, and notes the need to strengthen compliance with particular standards. Some municipalities do not even have the technical capacity to follow up and assess results, given the lack of skilled staff and financial means.

Environmental and development goals are often in conflict

The municipal authorities within the Valle de México, as in many other municipalities across the country, rarely take into account the recommendations of land-use planning in formulating municipal development plans. This has led, for example, to the use of land for housing when it is officially considered as conservation land. A lack of information and understanding persists of how environmental protection can contribute to economic development. State and above all municipal governments in the metropolitan zone still need to find a balance between development and environmental goals, particularly during the planning and enforcement stages. This issue also shows that achieving complementarities between economic growth and environmental priorities in the metropolitan area remain a challenge.

Although housing production, in the framework of sustainable development, widely uses eco-technologies, the authorities at all levels of government do not seem to take into account other aspects critical to sustainability, such as the urban and social impact of housing on citizens and on the habitat. Urban sprawl, the use of rural or conservation land, water demand, long commuting times and the difficulty for families of living in "dormitory cities" in small homes that cannot be adapted to their future needs are just some of the effects of housing policies on the environment (OECD, 2015b; Paquette, 2014). For example, 60% of the fuel used in the metropolitan area is to move commuters to and from their workplaces. This not only creates environmental damage through emissions but negatively affects the quality of life. State and municipal authorities in the State of Mexico and recently Hidalgo have largely focused on satisfying housing demand rather than on job creation in the municipalities, leading to the transformation of municipalities into dormitory towns.

Environmental awareness among citizens could be promoted

Residents' awareness and understanding of environmental issues remains weak despite governments' efforts. Progress in environmental protection and climate change action depends on citizens' engagement. Residents in the Valle de México appear to lack environmental information and education and are resistant to changing their habits. For example, small businesses are not willing to change their traditional equipment and production systems for cleaner technology because of the cost. Resistance among people living in risk zones to moving to secure places is another example. Citizens are aware of environmental problems, but not of their role both in creating the problem and resolving it. The strategies for development and climate change in both Mexico City and the State of Mexico promote the need for public consultation in forums and seminars, but there is little evidence of a strategy to actively engage the public in policy decisions, and the voluntary sector's involvement in climate change actions is limited. Local governments in the Valle de México recognise the need for cultural change to reduce pollution levels. If owning a car continues to be a necessity, change will be harder to achieve.

Urban planning as a tool for addressing environmental problems

In the Valle de México, the environmental problems related to water, air quality and solid waste and the threats to conservation land are the product of poor urban strategic planning and its dissociation from the environment. Integrating the environment into urban planning could be a significant contribution to pursuing climate change and resilience. For example, effective mass transit systems that prioritise non-motorised transport can reduce emissions and congestion and help improve public health. However, the urban form and density shape how efficient these systems can be. Moreover, efficient management of solid waste reduces the generation of methane, a powerful greenhouse gas. Effective landfill management can reduce emissions, and if located strategically, need not represent a threat to aquifers and soil. Architectural and urban design that reduces energy consumption and cost can reduce costs for residents and contribute to lower GHG emissions. Investing in water and sewerage treatment plants and on innovative urban design that integrates natural and built form to conserve ecosystem functioning could not only improve well-being but reduce the costs of conserving the environment.

Addressing the water challenge may increase environmental sustainability

Urban planning and water services should be closely linked to increase environmental sustainability. The focus on four pillars should continue: reducing demand, eliminating leaks, raising awareness and availability of water from other areas, and refilling aquifers. International experience suggests that urban areas can be very successful in reducing demand (Box 4.3).

The first pillar consists in reducing water demand in the Valle de México. Attempts have been made to reduce demand through awareness campaigns, often targeting schools. Uptake among children seems to be satisfactory, but the impact of the measures is not clear. Consumption has been fairly stable, despite campaigns in the Federal District to raise awareness and reduce consumption. Reducing demand is not made easier by the relatively low cost of water. As with any other good, consumers respond to an increase in price with a reduction in demand. Estimates of the "price elasticity", a measure of the responsiveness of demand to changes in price, tend to range between -0.4 and -0.6, implying that a doubling in prices reduces demand by about 40-60% (Grafton et al., 2011; Fuentes, 2011).[29]

Box 4.3. **Declining urban water consumption**

Per capita water consumption is declining in cities in OECD countries, thanks to a combination of increased system efficiency, deindustrialisation and lower levels of domestic use. The only exceptions in an OECD survey on water governance in cities are Hong Kong, China; Lisbon, Portugal; and the Federal District of Mexico.

- Industrial uses are declining, driven by efficiency gains and the shift from industry to services. Similarly, hospitals and schools tend to reduce their water consumption.
- Households have also reduced their consumption. While per capita water consumption initially dropped due to reduced outdoor use, indoor water use (chiefly through low-flow toilets and efficient washing machines) has also decreased.
- A growing number of utilities operators are seeing an additional decrease in consumption because households are finding alternative water supply solutions – e.g. rainwater harvesting – driven by environmental motives (reducing the energy footprint) or financial concerns (reducing the water bill). These households usually remain connected to the main infrastructure, and in some cases discharge water they have not purchased into the sewer, free-riding on the sewer service.
- Authorities contribute to this trend when they encourage users to conserve water. In California, the 2009 Water Conservation Act requires the state to achieve a 20% reduction in urban per capita water use by the end of 2020.

Source: OECD (2015c), *Water and Cities: Ensuring Sustainable Futures*, OECD Studies on Water, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264230149-en.

Keeping prices artificially low not only encourages overconsumption, but also holds back investment in water-saving technologies and counteracts efforts to build an environmentally sustainable water culture. This applies to both private households and the public sector. Prices are heavily subsidised in the Valle de México, especially in the Federal District. In 2008, more than 55% of SACMEX's budget came from subsidies. By 2012, the percentage of subsidies was reduced to one-third, but the total budget decreased by 15%, from MXN 12.2 billion to MXN 10.4 billion (USD 800 million)

in 2013 prices (SACMEX, 2013). This makes investment in major infrastructure difficult and creates obstacles in co-ordination across levels of government.[30]

Any adjustment to prices needs to be accompanied by measures to improve collection of tariffs. Only 74% of charges in the Federal District were recovered in 2013 (up from 61% in 2011). In the State of Mexico, payment rates vary significantly across municipalities. On average, 46% of bills were paid in 2013 (down from 67% in 2011). In response to the low rate of collection by municipalities, the CAEM, the Water Commission for the State of Mexico, introduced a chargeback system, in which transfers to municipalities are reduced if they do not collect their fees.

In addition to collecting fees, a necessary step in aligning incentives with reducing demand is to ensure that households are paying for their actual consumption. A lack of coverage with individual water meters results in a significant percentage of households paying fixed fees for their water. In the Valle de México metropolitan area, only 52% of households are metered. The percentage exceeds 90% in cities in other Latin American countries (see World Bank, 2013). Programmes for the expansion of meters have been implemented. Between 2007 and 2012, SACMEX increased the number of working meters from less than 600 000 to 1 253 626, but a significant shortfall remains, of about 25% of users, who mostly pay a fixed consumption fee.[31] A further advantage of having a meter installed is that awareness of actual consumption is raised. This can create a measurable impact on water demand by itself (Grafton et al., 2011) and amplify the reduction in demand that follows price increases.[32] Working meters are also essential to assess the efficiency of the water delivery system and to detect leakage.

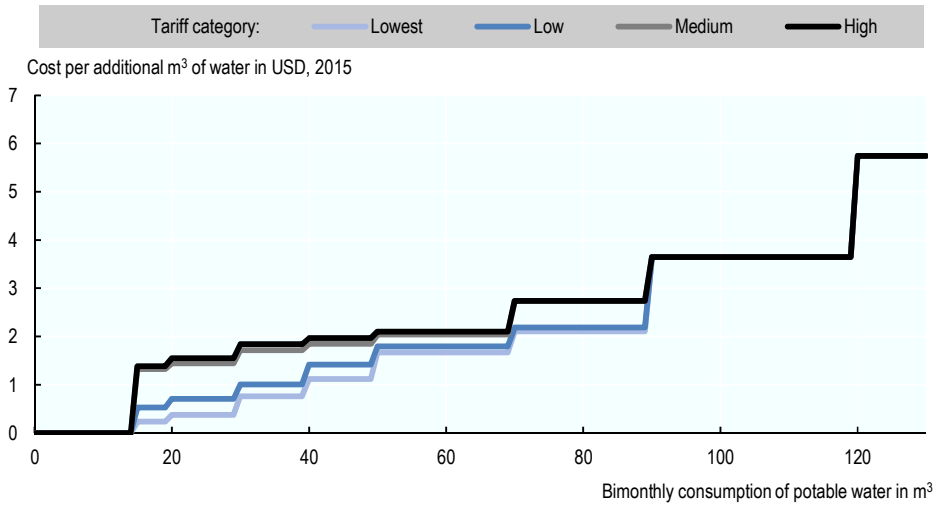
Adjusting tariffs is difficult, both politically, because changes require legislative approval, and socially, as water and its tariffs quickly become hotly discussed topics in local media. Short political cycles increase the pressure on policy makers to keep public opinion in their favour. Nonetheless, a successful strategy in reducing demand needs to consider adjusting prices. The social impact can be alleviated by allowing for higher increases for wealthy customers and those with relatively high consumption levels. Gains from increased tariffs could then help subsidise improvements in infrastructure and the expansion of meter coverage. It would also allow for subsidising less-affluent households, while moving towards water and fiscal sustainability.

The current progressivity of tariffs is fairly steep (starting at a very low rate; see Figure 4.8) for the lowest two tariff categories. The subsidy for these consumers is reduced with increasing consumption. For the 25% of households that pay the middle and high tariffs, prices per cubic metre are flat until they reach 70 m^3 in two months, corresponding to 288 litres per person (assuming a four-person household). This exceeds both the required level for sustainable water supply and average consumption levels typically found across Latin America.[33] The incremental increase in the relevant consumption range, below 70 m^3, is unlikely to have a significant impact on the behaviour of affluent consumers.

The second pillar in achieving sustainability is reducing leakage. Leakage arises both in the public infrastructure, i.e. in the main pipes that deliver potable water and on the "last metre", i.e. between the public system and the households and even in the household's own appliances. For the latter, water meters can help raise awareness of losses generated by faulty appliances and incentivise replacement. Public infrastructure, however, requires significant investment. The existing network of pipelines is under severe stress, especially pipes that are more than 40 years old. Estimates for the total loss from leaks (and illegal abstractions) vary, but even estimates at the upper end, around

38-40% losses, are considered realistic (see IADB, 2012). To assess the extent of the loss, further monitoring along the pipe network is required. Full mitigation of leaks is not economically viable, and the investment in infrastructure needs to be balanced with the cost savings in water provision. In water-rich areas, higher leakage rates are typically found to be acceptable, e.g. in Grenoble in France. But given the severe strain on the water resources in the Valle de México, investment in leakage reduction is likely to create significant returns.

Figure 4.8. **Progressivity of bimonthly water tariffs in the Federal District, 2015**



Note: Tariff categories for the Federal District are *popular* (lowest); *baja* (low); *media* (medium); *alta* (high). Tariffs are for 2015 and converted from MXN to USD using the average exchange rate for 2014.

Source: Government of the Federal District (2014), "Decreto por el que se reforman, adicionan y derogan diversas disposiciones del Código Fiscal del Distrito Federal", *Gaceta Oficial Distrito Federal*, No. 2012(I), 22 December, available at: www.sacmex.df.gob.mx/sacmex/doc/3_atencion_a_usuarios/tarifas/6_tarifas172.pdf.

Cracked and leaking pipes not only result in direct waste of potable water, but limit service delivery. The pressure at which water can be supplied is constrained, to avoid bursting pipes. This means that water will not be available to all households in the affected part of the network. Required replacements and an expansion of the existing network require significant investment, which is not covered in the operating budget of the utilities providers. This is seldom the case across the OECD. Among the three revenue sources for utilities providers, taxes, tariffs and transfers, governments decide on the most efficient mix of resources to manage trade-offs between economic efficiency, financial sustainability, environmental protection and social cohesion.

The third pillar to achieve a sustainable supply of water is to increase the available water. This pillar combines two strategies. The first is the utilisation of non-freshwater sources. For private households, collecting rainwater to use for watering green areas is encouraged. In the public sector, coverage of water treatment facilities is being expanded. The largest water treatment plant in Mexico is currently being constructed in the Tula Valley, north of the Valle de México. It has a planned capacity of 35 cubic metres per second (m^3/s), of which two-thirds will result in "safe to handle" water and one-third in water that can be drained into rivers and dams (see CONAGUA, 2015). Given the plant's location, the benefit of the plant will be outside the Valle de México. In the Tula Valley, the majority of the city's untreated wastewater is used to irrigate

100 000 hectares of agricultural land. The raw sewage is appreciated by the farmers, as it significantly increases yield for crops. But the higher yields come at a price. The sewage is detrimental to residents' health and given the high permeability of the agricultural soil, its use has the unintended side effect of artificially recharging the aquifer underlying the irrigated area with 25 m^3/s of raw wastewater (see WHO, 2003: Chapter 3). While it might seem counterintuitive to construct water treatment facilities outside the metropolitan zone, the benefits of treating water to become "safe to handle" are likely to be higher in the Tula Valley than in the metropolitan zone. The possible use of "safe to handle" water in the urban parts of the Valle de México is probably limited. Its main use is for agriculture and gardening, and the majority of water used in these areas in the Federal District is treated water.

The second strategy to increase supply is the expansion of the water delivery systems from external aquifers. New lines are being considered, and a third line is planned for the Cutzamala system (see CONAGUA, 2015). Adding a third pipeline will facilitate required refurbishments of the existing pipes, which were built 40 years ago. However, importing water from neighbouring basins cannot be the main strategy to supply water to the ZMVM, because this practice has created social and political conflicts and led to regional deficits of water (Escolero Fuentes et al., 2010). The water tariff in the Valle de México does not reflect the environmental damage to the Lerman and Cutzamala basins. Moreover, the costs associated with water delivery across long distances (and heights) are high, and increased reliance on surface water systems increases vulnerability to climate change. Extended dry spells and droughts can lead to severe depletion of the reservoirs and make the water system susceptible to risk from climate change. In 2014-15, São Paulo experienced a severe drought and had to implement a range of immediate measures that helped alleviate the pressure on the water infrastructure, but short-term adjustments are unlikely to result in sustainable solutions (Box 4.4). Without addressing the dual water challenge, the Valle de México can neither achieve sustainability nor resilience to climate change. Both aspects require a concrete long-term strategy, developed jointly by all stakeholders in the metropolitan zone, the basin and at the national level. But both aspects also require immediate action to stop further depletion of resources and enhance the quality of life of the metropolitan zone's residents.

Box 4.4. **Drought response by São Paulo's sanitation services**

In 2014, the Basic Sanitation Company of the State of São Paulo (Companhia de Saneamento Básico do Estado de São Paulo, SABESP) had to respond to the worst drought in 84 years. Water inflow was significantly reduced and remained even below values recorded in 1953, formerly the driest year on record. In addition, high temperatures well above summer averages led to greater consumption of water and greater evaporation, thereby causing a continuous decrease in the volume stored in the main surface water system. In response, the SABESP has implemented a series of measures:

- substitution of water supply from the most affected parts of the system to other sources
- introduction of discounts (bonus) to consumers using below-average amounts of water
- reduction in the pressure in the water distribution lines, to decrease leakage
- reduction of the volume of treated water sold wholesale to municipalities that own their distribution network

Box 4.4. **Drought response by São Paulo's sanitation services** (*continued*)

- installation of new pumps and delivery routes to extract water located below the intakes of the existing water storage system, from the so-called "technical reserve", which had never been used to serve the population.

The SABESP estimates that as of March 2015, the implementation of the bonus programme accounted for 19.8% of water savings in the most affected part of the system. The reduction of pressure in water distribution lines and initiatives mitigating water losses accounted for 41.2%, the transfer of water between production systems for 35.6% and the reduction of the volume of wholesale water transfers for 3.4%.

With the continuation of the drought into 2015 and a low level of inflow into the reservoirs, the SABESP implemented further measures:

- The period to which discounts (bonuses) apply was extended until the end of 2015, or until reservoir levels normalise, depending on which occurs first.
- The SABESP was authorised in January 2015 to introduce a contingency tariff that increases the water bill for above-average consumption. Customers who consume up to 20% more than the average pay 40% higher tariffs and consumption above 20% of the average results in a tariff increase of 100%.
- The intensification of the reduction in water pressure was extended, increasing the periods of reduced pressure.

Due to the crisis, a series of short- and medium-term emergency investments have been and will be required to continue providing water to the population. These investments resulted in an increase in costs and change in capital expenditure. If the drought does not end and further investments are not possible, the SABESP expects that more drastic measures might be required, including rotating rationing, to ensure continued service provision.

Source: SABESP (2015), "Form 20-F (filing date 29 April 2015)", Companhia de Saneamento Básico do Estado de São Paulo, available at: www.sabesp.com.br/sabesp/filesmng.nsf/04F592CBAA86C3EB83257E3600833CB6/$File/sbsform20f_2014.pdf.

The fourth pillar is to recharge local aquifers. Mexico City's main aquifer is recharged through natural infiltration in the Sierra de las Cruces and Sierra del Chichinautzin that form the western and southern boundary of the metropolitan area respectively. But sustainability can only be achieved if abstractions are significantly reduced or artificial refill is used and urbanisation in this area is controlled and there is a wide campaign of reforestation through the *Pago por Servicios Ambientales* (Payment for Ecosystem Services) programme.[34] Refilling aquifers via pumps risks contaminating the groundwater, and even refill via pumped groundwater from external aquifers can lead to contamination.[35] Moreover, using the New Mexico City International Aurport as a testbed, the long-term flood protection measures for the Valle de México should shift from costly drainage tunnels (to drain both waste and rainwater) towards the closing of open sewage canals (to separate waste and rainwater) and expansion of the local rainwater storage capacity at the local level. Smaller scale solutions, such as retention ponds and eco-roofs in industrial and residential neighbourhoods, could make a difference in reducing the pressure on the piped wastewater system and promoting reuse of rainwater. A good example can be found in Portland, Oregon, where a city-wide watershed management plan aims to increase natural drainage of rainwater to reduce the high cost of piped infrastructure investment (Box 4.5).

As part of the effort to build a resilience strategy for Mexico City, drought scenarios will be simulated, with different resilient investment portfolios. This could be the basis for a solid response in the event of serious drought. It is nevertheless important to protect the highest parts of the basins, the refilling zones and the local climate. Declaring refilling zones natural protected areas would be one useful strategy if it is accompanied by adequate enforcement. Including water issues in urban planning would help locate areas that could store rainwater (Escolero Fuentes et al., 2010).

Box 4.5. **Portland's green infrastructure**

The City of Portland, Oregon, promotes green infrastructure, which is defined as interconnected natural systems and/or engineered systems that use plants and soil to slow, filter and infiltrate runoff close to its source in a way that strengthens and mimics natural functions/processes. The 2005 Portland Watershed Management Plan provides the scientific framework for watershed improvements, with an emphasis on hydrology. A big part of this is understanding that restoring the hydrologic cycle has a significant role in watershed health and protects both Portland's piped infrastructure investment (capacity) and its rivers and streams at less cost. Green streets and eco-roofs are among the most typical green infrastructures:

- **Green streets** consist of swales, linear facilities that collect and often convey storm water. Storm water flows into the swale and soaks into the ground as the vegetation and soil filter pollutants. This keeps storm water from flowing to sewers or into rivers and streams. It also replenishes the groundwater, which feeds cool, clean water to rivers and streams. The first curb extension was built in 2002. There are already more than 900 green street facilities in Portland. It was successful partly because the initiative was started as a pilot project that would have been discontinued if it had been unsuccessful. Different designs were then developed for different situations. Green streets have also enhanced pedestrian safety by shortening crossing distances, and are sometimes considered to slow traffic. Neighbours consider them a real asset to the neighbourhood because they provide water quality and habitat benefits and increase property values.
- More and more **eco-roofs** are being built in Portland. As of 1 July 2010, Portland had a total of 250 projects for over 12 acres. Since 2008, nearly 100 incentive projects have been accepted for an additional 5.6 acres, despite the recession and economic downturn. The approach seems to be working. Incentive funds have been awarded and interest is growing.

Source: OECD (2012d), *Compact City Policies: A Comparative Assessment*, OECD Green Growth Studies, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264167865-en.

Urban air quality management could be boosted by synergies with other sectors

Improving air quality requires synergies from different sector activities. For instance, reducing air pollution produced by cars would require reforming vehicle inspection (*verificación vehicular*), imposing uniform inspection and maintenance standards in the entire megalopolis. This programme should accelerate the disposal of old and inefficient cars. Buses, trucks and motorcycles should be included in the compulsory vehicle inspection. Improving fuel quality should also be part of this strategy. Using less diesel would address the problem of black smoke from heavy diesel-powered buses and trucks that operate in the metropolitan zone. The introduction of alternative fuels such as compressed natural gas (as India has done), biofuels from crops, or used cooking oils or biogas from sewerage and waste should be analysed as long-term alternatives. The city of Kyoto, Japan, collects used cooking oil from the residents to make fuel, under the biodiesel fuel project launched in 1996. The city's 92 buses and 136 garbage collection

trucks are now operated on biodiesel fuel (City of Kyoto, 2015). Promoting the use of three-way catalysts that can reduce emissions or particle filters for diesel vehicles, and the adoption of hybrid technology could have a positive impact in air quality. Moreover, as discussed in Chapter 3, authorities must re-examine urban transport demand from a metropolitan perspective and devise new strategies that provide maximum accessibility. The challenge is to expand and improve public transport supply so that the automobile becomes part of the transport system rather than its central focus. But discouraging the use of cars will only be possible if efficient and economic transport alternatives are offered (bus, light rail, underground, ferries, walking or cycling). Improving the transport system will require a combination of policies that reinforce each other and help avoid adverse side effects. The OECD has found that in cities where more people commute by public transport, CO_2 emissions per capita from transport tend to be lower, whereas in cities where people commute by car, CO_2 emissions per capita tend to be higher (OECD, 2013b).

The *Hoy No Circula* programme could be updated. Adopting more stringent restrictions for poorly performing vehicles, including motorcycles and freight transport in the programme, and gradually scrapping cars more than 20 years old are some options (Centro Mario Molina, 2014). Other alternatives could include taking out of service public transport vehicles that do not have environmental technology, promoting the yearly renewal of catalytic converters in buses, taxis and trucks, or even implementing the *Hoy No Circula* only during contingencies – based on odd and even numbers on license plates – as in Paris. The *Hoy No Circula* programme alone will not help to improve air quality; it will need to be complemented with strategic urban planning, transport-oriented policies and zoning. Better transport would allow government to enforce stricter regulations, reducing the number of old cars in circulation. Imposing a uniform car-ownership tax (*tenencia vehicular*) across the six entities of the megalopolitan region would improve air quality and increase the financial resources of state-level governments.

Mass public and non-motorised transport should continue to be part of the environmental strategy, but with a metropolitan approach. Individually, the Federal District and the State of Mexico have introduced a number of mobility initiatives (see Chapter 3) in a quest to improve the air quality in the metropolitan area and reduce energy consumption. For example, the Federal District's BRT Metrobús system is expected to help reduce pollution (120 000 tonnes of CO_2 emissions per year) and to help with the urban regeneration of green areas. The ECOBICI bike-sharing programme has helped reduce 1 395 tonnes of CO_2e, equivalent to planting 4 100 trees between 2010 and 2014.[36] Authorities in Mexico City are also renewing the Passenger Transport Network (Red de Transporte de Pasajeros, RTP) bus fleet with new, less-polluting buses. In 2014, the RTP bus introduced 2 lines of the EcoBus, with 2 hybrid buses and 72 natural gas buses (in a fleet of 1 360 buses).[37] The RTP faces two main challenges: the fact there are only three natural gas stations in Mexico City and the lack of financial resources to replace old buses. Such initiatives need to complement each other as part of a metropolitan transport strategy if they are to be effective.

One desirable step would be to consider aligning Mexican air quality standards with the international standards set by the World Health Organization (WHO). This would provide policy makers with appropriate targets for air quality management and ensure buy-in from national environmental groups. The new standards would be based on an extensive international body of scientific research relating to air pollution and its health consequences. Although WHO acknowledges that every country should consider its own circumstances, technological feasibility and economic needs before adopting international

guidelines as legally based standards, authorities in the Valle de México have shown they have the experience, political commitment, economic means and technology to upgrade their standards.

Efforts to reduce air pollution from industrial sources in the Valle de México should also be reinforced. Better information is needed on polluting industries, the type of pollutants emitted, the trends of the pollutants and what is currently being done to reduce the trend. Some strategies to reduce industrial pollution could include physical planning or zoning by: 1) restricting the location of new industries close to residential zones; 2) relocating existing industries, if economically viable; 3) creating special control areas or smoke-free zones; 4) area planning based on emission assessments and air quality objectives, to determine the type of control needed; and 5) compulsory environmental impact assessments for new major industries, to assess potential air pollution and develop recommendations for improvement in choice of location and pollution equipment.[38] Promoting cleaner production is another option available. This would mean increasing the efficiency of industrial processes and the use of products to prevent the pollution of air, water and land, reducing waste at its source and minimising health risks. Poor solid waste management also contributes to air pollution, and a comprehensive system of waste collection is essential (see below).

Authorities in the Valle de México should ensure the compatibility of new and existing environmental strategies at city, regional and national level. Integration of land-use planning with transport planning and air quality management, all of which directly influence the metropolitan zone's air quality, requires greater co-ordination. The aim should be to avoid sending contradictory messages to the wider public. The experience of the US Clean Air Act, which seeks to ensure that transit and highway projects are consistent with ("conform to") air quality goals, could be a valuable example for the Valle de México. The mobility impact assessment proposed by the Ministry of Mobility of the Federal District (Secretaría de Movilidad del Distrito Federal, SEMOVI) is a step in this direction.

Greening of the building sector and other key urban infrastructure requires greater integration of environmental concerns and investment decisions. Valuable initiatives are already in place at federal and local level, but they need to be co-ordinated and integrated into regional/metropolitan planning. In the area of housing construction, to reduce energy consumption and reach its target of reducing CO_2 emissions by 50% by 2050, Mexico's federal government is adopting the "whole house approach" that includes technological development and housing design. In 2012, Mexico's National Housing Commission (Comisión Nacional de Vivienda, CONAVI) adopted the National Appropriate Mitigation Action (NAMA) for sustainable housing. Since 2013, all new social housing in the country has been built with eco-technologies. More recently, the Mexican government has been piloting a NAMA for existing social housing, which aims to improve the existing housing stock using eco-technology, in collaboration with local and municipal governments, and raise the standards used for new houses.

One of the most important projects of the NAMA is ECOCASA, which finances the construction of energy-efficient homes for low- to middle-income families. The Federal Mortgage Society (Sociedad Hipotecaria Federal, SHF) provides bridge loans with a preferential rate for developers to construct houses using eco-technology. This project is expected to help cut over 1 million tonnes of GHG emissions over 40 years, the estimated lifecycle of these houses. It also intends to support the construction sector and to promote

Box 4.6. Conformity between transport and air quality management planning in the United States

The US government has introduced a policy of transport conformity, integrating air quality and transport planning. The air quality plan seeks to minimise emissions, while transport planning seeks to increase mobility. Transport activities are not funded or approved unless they conform to the purpose of the air quality plan. No transport activity should result in new violations of air quality standards or exacerbate existing violations, or in any delay in the planned improvement of air quality. The transport plan funds transport control measures in the air quality plan, calculates motor vehicle pollution inventory and matches the air quality budget. Conformity is required in areas that do not meet, or previously have not met, air quality standards for ozone, carbon monoxide, particulate matter or nitrogen dioxide. A conformity determination estimates emissions that will result from an area's transportation system, and demonstrates that those emissions are within the limits outlined in the state's air quality implementation plan. The conformity process is administered jointly by the US Environmental Protection Agency (EPA) and the US Department of Transportation. This requires shared data and identical assumptions between transport and air quality plans to generate realistic measures.

Several US cities have added new projects and measures to meet their air quality and transportation goals for the one-hour ozone air quality standard. For example, Beaumont-Port Arthur, Texas, provided truck stop electrification to reduce vehicle idling; Houston, Texas, implemented a heavy-duty diesel retrofit and replacement programme; Atlanta, Georgia, used the conformity process to assist agencies in addressing a significant increase in vehicle miles travelled, re-evaluated transportation planning goals, and added new transit and land-use initiatives; and Charlotte, North Carolina, addressed increased vehicle miles and the resulting emissions increases by creating a long-term transit and land-use plan.

Sources: US Environmental Protection Agency (2006), "The bridge to cleaner air: Transportation conformity", Office of Transportation and Air Quality, United States Environmental Protection Agency, Washington, DC, January, available at: http://epa.gov/otaq/stateresources/transconf/420f06001.pdf; UNEP (2005), "Urban air quality management toolbox", United Nations Environment Programme, United Nations Human Settlements Programme, Nairobi, available at: www.unep.org/urban_environment/PDFs/handbook.pdf.

the use of eco-technology; and increase the comfort of residents and lower their electricity bills. This is a complex project, as it requires the co-ordination of several actors in the housing sector, including CONAVI, the National Workers' Housing Fund Institute (Instituto del Fondo Nacional de la Vivienda para los Trabajadores, INFONAVIT) and housing developers. It has been necessary to build the technical knowledge of developers on eco-technology, to prepare suitable proposals, adopt adequate incentives to attract private developers and create a robust and feasible monitoring, reporting and validation framework.[39] As an example of sustainable housing construction, the ECOCASA programme won an award for climate protection from the United Nations during the COP19 in Warsaw in 2013. In 2007, INFONAVIT created a "Green Mortgage" (*Hipoteca Verde*). Almost all mortgages awarded by the institute to buy, build, remodel or improve a house are required to use eco-technologies to save water, electricity and gas. Initially, the green mortgage was allocated as an additional amount of credit to those who asked for it, but since 2011, all credits granted by INFONAVIT have been dedicated to houses using eco-technology.[40] Between January and July 2015, 96.2% of the credits for new housing and 94.4% of the credits for used houses were part of the green mortgage scheme. It would be helpful to align these projects with transport and air improvement plans, to avoid negative side effects due to, for instance, poor urban planning. In the same vein, in 2008, Mexico City's government introduced the Certification Programme for Sustainable Buildings, under which local authorities transform and adapt existing and future buildings using sustainability criteria

and environmental efficiency. When a building receives the certification, the owners are entitled to fiscal incentives, of either a 40% reduction in payroll tax or a 20% reduction in property tax (SEDEMA, 2008).

The metropolitan zone needs a sustainable approach to waste management

In the Valle de México, the main motivations for better solid waste management are to avoid groundwater contamination, soil pollution, the bad smell, generation of GHG emissions and health hazards. The ZMVM lacks an effective collection and disposal system. A first priority would be to develop an adequate waste management system and then focus on waste reduction measures. For the Valle de México, as for any large metropolitan area, managing waste properly requires addressing all three key drivers of a sustainable waste management system: public health, with a focus on waste collection and street sweeping; the environment, focusing on improving disposal to protect ground and surface water and avoiding air, water and soil pollution; and resource recovery, to close the loop of both materials and organics management (Wilson and Scheinberg, 2010). The overarching idea is that the metropolitan zone as a whole should aim at landfilling less waste and recycling more. The *Basura Cero* programme could be the basis for a comprehensive metropolitan initiative. However, its results need to be evaluated, so that it can be improved and eventually expanded to the entire metropolitan zone, in co-ordination with the authorities in the State of Mexico.

There are several areas where the Valle de México needs to act on waste management. First, authorities need to build new disposal sites and renovate existing sites, with adequate protection for the environment and public health, and also to gradually introduce recycling. Second, the authorities should phase out open dumps – as has already been achieved with the Bordo Poniente landfill – and inadequate collection systems. Lastly, measures could be taken to increase separation at the source and ensure that less waste goes to disposal sites. Since the Valle de México is somewhat heterogeneous in terms of capacity and resources, the modernisation of its solid waste management system should start with the identification of simple, appropriate and affordable solutions that can be implemented progressively. Early steps could include extending collection to the whole metropolitan zone and measures to raise awareness of the importance of waste separation. The experience of the Netherlands in managing solid waste could be helpful to authorities in the Valle de México, as an example of how growing environmental awareness among the Dutch people led the government to reduce the space for landfills (Box 4.7). The Valle de México should learn from the Dutch experience that without a system of laws and regulations for waste materials, and control measures established from the outset, all waste could end up in a landfill. If the authorities want to promote the participation of private waste-processing companies, it needs to give them the possibility of developing profitable activities. With mandatory and prohibitory provisions and taxes, a better grade of waste processing can be enforced.

The experience of OECD and EU countries provide authorities in the Valle de México with some policy instruments to incentivise a shift up the waste hierarchy. Table 4.5 presents a non-exhaustive overview of those policy instruments, which can be designed and implemented in different ways to influence their effectiveness. Those presented in Table 4.5 are options authorities in the Valle de México might explore. Important lessons for the Valle de México that can be drawn from OECD-EU countries' experience are that: 1) using a wide variety of instruments increases the chances of a higher level of waste recycling; 2) a regional waste management plan generally achieves good waste recycling results; 3) the management waste plan needs to

be complemented with additional initiatives to establish better infrastructure or divert waste from landfills; 4) increasing the landfill tax by more than 50% in the medium term and introducing a landfill ban on organic waste or non-pre-treated waste can help achieve good results; 5) countries that have introduced mandatory separation of certain elements of waste, e.g. waste paper, in addition to packaging waste, or mandatory separation of biowaste, have high recycling levels; and 6) economic incentives for households to recycle their waste (e.g. pay-as-you-throw schemes, requiring payment fees based on the weight of the residual, and not separately collected waste, the size of the residual waste bin or the frequency of collection) have mostly performed better than waste collection fees based on the property value, size of the property, household size or similar criteria (European Environmental Agency, 2013). Experience suggests that users should be asked to pay for collection and street sweeping, since they can see the results and need the services. In the Valle de México, fees for collection and street sweeping should be collected by government and not by informal workers. State-of-the-art landfills are best financed by a combination of central government financing supplemented by cross-subsidies between rich and poor.

Box 4.7. **The Netherlands' "Lansink's Ladder" waste management system**

The Netherlands has a highly efficient waste management system that allows it to recycle more than half of its waste. Most of the remainder is incinerated to generate electricity. As a result, only a small percentage ends up in landfills. The Dutch system avoids as much as possible creating waste, recovering the valuable raw materials from it, generating energy by incinerating residual waste, and only then dumping what is left over in an environmentally sound fashion. The Netherlands has little space for disposal sites and Dutch people are environmentally aware (more than 90% of Dutch citizens separate their household waste, and 75% seek to reduce water and energy consumption). As a result, the Dutch government took measures to reduce landfilling. This gave private companies the confidence to invest in environmentally sounder solutions to manage waste. The deciding factor was regulations known as "Lansink's Ladder", after the member of the Dutch parliament who proposed them in 1994. Over the years, recycling targets were set for the various waste streams, such as organic waste, hazardous waste and construction and demolition waste. Introducing a tax on every tonne of material landfilled was critical, because it gave waste-processing companies the incentive to look for other methods – such as incinerating and recycling – because they were more financially attractive. Landfilling waste in the Netherlands costs EUR 35 per tonne, plus an additional EUR 87 in tax if the waste is combustible, which overall is more expensive than incineration.

Source: Feller, G. (2015), "Dutch successes: Public and private sector aren't wasting their time", *Waste Management World*, www.waste-management-world.com/articles/print/volume-11/issue-1/features/dutch-successes.html (accessed 15 August 2015).

The Valle de México needs to make better use of economic instruments for waste management. Municipal-level governments in the Valle de México could follow the example of other Mexican cities, such as Aguaprieta, Mérida, Puebla and Tehuacán, in imposing charges for household waste collection. These cities levy flat-rate charges differentiated by city area, with lower rates for poorer areas. Authorities in the Valle de México could further make these charges quantity-based, to encourage waste reduction. One area of attention is the limited municipal institutional capacity and the role of informal workers (*pepenadores*) in the waste sector. In Mexico City, household waste charges are prohibited by law. While there is wide social resistance to paying for formal waste collection, much of the population pays tips to informal waste pickers, sometimes more than municipal waste charges would be. To introduce waste charges, local governments will have to work with informal workers to ensure effective implementation of a waste management system (OECD, 2013b).

Table 4.5. **Municipal solid waste management and selected policy instruments in European countries, 2001-10**

Policy instrument	Austria	Germany	Belgium	Netherlands	Switzerland	Luxembourg	Norway	France	Finland	Poland	Czech Republic
Percentage of MSW recycled per MSW generated, 2010	63%	62%	58%	51%	51%	47%	42%	35%	33%	21%	16%
Two or more national waste management plans developed between 2001 and 2010	X	X		X		X			X	X	
Only regional waste management plans			X		X						
Landfill tax increased more than 50% from 2001 to 2010	X		X	X (abandoned in 2012)				X	X	X	X
Landfill tax at least 30 EUR/tonne MSW, 2010	X		X	X			X		X		
Incineration tax	X		X	X (but zero)	X		Until 2010	X			
Landfill ban on organic waste or non-pre-treated MSW	X	X	X	X	X	X	X	X	X	X	
Mandatory separate collection of non-packaging waste	X		X		X		X		X		
Mandatory separate collection of bio-waste fractions	X			X		X				X	
Economic incentives for recycling of MSW (pay-as-you-throw, etc.)	X	X	X	X	X	X	X	X	X	X	X
Selected innovative policies	(1)	(2)	(3)			(4)		(5)	(1)	(6)	(7)

Notes: MSW: municipal solid waste.

1. Separate collection of waste paper. 2. Introduction of a recycling bin for plastics and metals. 3. High household fines for non-compliance in source separation, maximum generation of residual MSW per capita, recycling quality standards. 4. Design standards for separate collection in new households, one container per 10 000 inhabitants, 100% of population covered by separate collection. 5. National extended producer responsibility introduced, e.g. on non-packaging paper, textiles and furniture. 6. Government fund co-financing recycling activities. 7. Quality standards on composted biowaste.

Source: European Environmental Agency (2013), "Managing municipal solid waste: A review of achievements in 32 European countries", EEA Report No. 2/2013, European Environmental Agency, Copenhagen.

Climate change measures need to be linked to urban planning

The Valle de México is exposed to a range of climate-related hazards, and many of its residents are highly vulnerable to climate change, mainly low-income people. Energy shortages, damaged infrastructure, increasing losses to industry, changes in rainfall patterns which could reduce freshwater availability and food production, heat-related mortality and illnesses are some of the likely economic and social effects of climate change. The vulnerability of the Valle de México and its residents to climate change is shaped not only by their exposure to particular hazards, but also by the sensitivity of social, economic and environmental systems, and by the capacity of these systems, including urban households and communities, to adapt. Some groups may be particularly affected: for example, children and the elderly are more susceptible to extreme heat and air pollution. The urban poor located in informal settlements are highly exposed to hazards such as floods. Adapting the Valle de México to climate change can be best achieved through addressing underlying development and infrastructure deficits. Integrating climate change mitigation and adaptation in urban planning and management has significant potential to address these issues, in association with other economic and social challenges. The experience of cities in Germany, the Netherlands, the United Kingdom and the United States suggests that a climate change action plan is not enough on its own. The most effective strategy is to incorporate the environment into existing planning tools, rather than developing stand-alone approaches.

In the Valle de México, the challenge for state-level authorities, as in many other OECD countries, will be to enlist the commitment of the different departments and units in the municipalities. Climate change needs to be seen as an issue for the whole municipal government and not just for an under-funded environmental unit. State-level governments will need to produce a clear high-profile public statement or declaration on climate change and environmental protection, setting out policies, targets and key actions. This should be linked to the more detailed urban planning and municipal development programmes, making clear what the plans and programmes seek to achieve. However, experience also suggests that the inclusion of environmental concerns in strategic development documents does not necessarily mean that these are taken seriously or result in meaningful changes. Much depends on changing budgets, laws, attitudes and politics. Given the governance challenges the Valle de México is facing, it may be more effective to concentrate support on a single issue that is a national priority, and is the responsibility of the state-level authorities, such as water service delivery.

Mexico City and the State of Mexico have issued climate change action laws and programmes to reduce the environmental, social and economic risks of climate change and promote the welfare of the population. Mexico City's Climate Action Programme (*Programa de Acción Climática de la Ciudad de México 2014-20*, PACCM) aims to increase the city's resilience as well as the population's adaptation capacities, particularly for the 5.6 million people most vulnerable to the consequences of extreme weather events, such as flooding. The State of Mexico's Climate Change Action Programme considers water, agriculture, forestry and human settlements key priority sectors, and includes issues such as gender equality and preservation of the cultural heritage as part of the programme. Its goal is to plan the metropolitan growth zones of the Valle de Toluca and the Valle de México with climate change adaptation criteria. However, a metropolitan climate change action programme developed and implemented by all relevant authorities in the Valle de México would provide a more coherent and co-ordinated approach. The ZMVM would be treated as a whole and would not be divided by two programmes with different priorities and levels of development.

The ZMVM is uneven in its socio-economic development: different areas face different environmental and urban challenges that require appropriate responses. Mexican authorities may wish to request the Environment Commission for the Megalopolis (CAMe) to provide guidelines for state- and municipal-level governments to link environmental concerns and urban planning that are broadly applicable, and which can be adapted to the needs of urban sub-centres in a range of situations. Flexibility in policy implementation can introduce urban-level policy responses that can be scaled up. Management practices should also be flexible and adaptable, and lessons learnt and local context-related knowledge should be taken into account when assessing climate change strategies (Frohlich and Knieling, 2013).

Box 4.8. **Mexico City's Climate Action Programme**

The primary objective of Mexico City's Climate Action Programme 2014-20 (PACCM) is to improve the quality of life and low-carbon sustainable development in Mexico City. The PACCM is expected to achieve the direct mitigation of approximately 8 million tonnes of CO_2e up to 2020. The criteria that govern the programme are: build consensus among agencies of the government of the Federal District; strive for social equity and gender equality; improve the quality of life of citizens in the framework of sustainable development; communicate between federal and local public programmes; include society and decision makers, and maintain flexibility to adapt the programme to technological advances. The PACCM was extended for two years beyond the current administration's term to allow the next administration to assess the current programme and design a new one. The PACCM has seven strategic priorities, aligned with the local climate action strategy: 1) urban and rural energy transition; 2) containment of urban sprawl; 3) environmental improvement; 4) sustainable improvement of natural resources and biodiversity; 5) building resilience; 6) education and communication; and 7) research and development.

All of the actions of the PACCM have been assigned a scope, objective, implementation strategy, and follow-up and impact indicators. Of the 69 measures, 20 were considered as priorities and fundamental to achieve the plan's goals, taking into account the availability of resources, which is a limitation for the programme.

Source: SEDEMA (2014), *Programa de Acción Climática de la Ciudad de México 2014-2020*, www.sedema.df.gob.mx/sedema/index.php/temas-ambientales/cambio-climatico (accessed 15 August 2015).

The call for a metropolitan resilience framework to inform urban planning and investment

The authorities in the Valle de México may wish consider developing a resilience framework for the entire metropolitan area. The CAMe will lead the working group formulating a resilience agenda at the level of the megalopolis, which is a promising step, given that a comprehensive approach to resilience and overcoming the administrative fragmentation of the ZMVM is called for. This resilience framework should inform urban planning and investment patterns based on measurable evidence. It should also relate resilience to areas over which authorities have some control, such as infrastructure, public services, education, risk management, etc. A resilience framework for the Valle de México should include a metropolitan vision, an integral development strategy and plans that are regularly reviewed and updated. It is essential that the resilience framework consider the metropolitan zone as a whole, avoiding administrative, territorial divisions. The threat of climate change does not respect administrative borders, and addressing environmental shocks or stresses in isolation cannot serve resilience. A

metropolitan resilience framework should be led by the federal and the three state-level governments, which should ensure adequate financial resources for the project. Municipal-level governments, private sector agents and NGOs should also be part of the discussions.

Mexico City's experience in building a resilience strategy could serve as a reference for a metropolitan-wide effort. Its underlying idea is to develop more capacity at the community and government level to confront disaster risks. It will also involve taking advantage of any natural or man-made disasters to improve urban development and the quality of life in the city. This strategy must be ready in early 2016. To this end, Mexico City's government has created a Resilience Steering Committee, involving 17 organisations from the Federal District government, the CAMe at the megalopolis level, civil society, members of the private sector and academic organisations. Five working groups, which represent the pillars of the strategy, have been established: 1) creation of a resilience agenda at the level of the megalopolis; 2) resilient urban and land-use planning; 3) building a resilient watershed in the Valle de Mexico; 4) resilient infrastructure and economy; and 5) sustainable and resilient mobility. So far, 290 initiatives for resilience have been identified, of which 90-95% are existing initiatives to be analysed for their impact. The different work streams of the resilience strategy still need to be ratified by the Climate Change Inter-ministerial Commission, but the political support of Mexico City's Mayor is expected to encourage the participation of all relevant actors. Mexico City's resilience strategy (and an eventual metropolitan equivalent) should assess how sensitive the region can be to ever-increasing uncertainty; how well-conceived, constructed and managed its physical assets are; whether it has spare capacity to accept disruption; how flexible and resourceful it can be in changing circumstances; whether there has been a broad consultation and engagement of communities, including the most vulnerable; and more crucially for the Valle de México, how consistent the system is, to ensure that all investments mutually support a common outcome.[41]

Governance alternatives to environmental threats

Tackling the environmental challenges in the Valle de México will require paying attention to governance arrangements. Meaningful long-term changes in the environmental sphere cannot happen without sound governance and decision-making structures that are horizontally and vertically integrated (Dodman, Dalal-Clayton and McGranahan, 2013). Environmental challenges and solutions typically do not fall neatly into one specific area of expertise. A comprehensive strategy across sectors is necessary to balance and integrate different claims and to avoid or minimise conflicts between different aims. Governance arrangements provide a basis for the use of specific tools for including the environment in urban planning and management. At the same time, flexible environmental strategies are needed, because the scope of decisions is subject to considerable political and budgetary uncertainty (Frohlich and Knieling, 2013).

Building a long-term vision, and facilitating inter-municipal co-operation

Moving the Valle de México towards a commonly agreed direction in sustainable development is of critical importance. A long-term vision is needed, considering all possible risk scenarios, for how the metropolitan zone should promote economic development and limit the impact on the environment and natural resources. The long-term impact of climate change, over the next 50-100 years, requires not only a long-term vision, but intergenerational thinking that far exceeds the timeframes of the

existing responsibilities in policy making and planning (Frohlich and Knieling, 2013). For example, Portland's Climate Change Preparation Strategy builds on existing work to understand how climate is affecting the community, how those effects are expected to change in the coming century and what can be done to prepare for them.

A metropolitan view of environmental policy and programmes should underpin that vision. Clear progress has been made on environmental policy actions in air quality, but other issues, such as waste management and water provision are addressed in a more parochial manner.

The participation of a range of stakeholders in decision making is a key element of building a more resilient and environmentally aware metropolitan zone. Portland's experience suggests that the only way forward for implementing a climate action plan effectively is through collaboration and co-ordination with other public and private sector partners. This will require identifying lead bureaus, agencies and departments, and clarifying responsibilities to ensure accountability in the process.[42] Climate change strategies in London and Toronto and the green growth strategy of Kitakyushu in Japan have shown the importance of valuing and working with civil society. If climate action programmes are to be successful, they require high levels of public engagement. Local voluntary groups can help build that engagement, as they are often more trusted than local or central government by those they work with. However, it is equally important that voluntary groups focus on climate change and build their leadership skills.[43]

Pursuing a climate-sensitive form of governing could be a part of the vision and a way to achieve it. This would require, for instance, the integration of climate change adaptation and mitigation issues in different sectors such as energy, transport, housing and construction, urban planning, water management, conservation land, health and even agriculture. Authorities in the Valle de México may need to analyse the most appropriate instruments or regulatory tools needed, sector by sector, to direct the behaviour of the different actors towards climate-friendly development. Table 4.6 shows some of the formal, informal and economic instruments that could be used to enhance a climate-friendly governance model.

Table 4.6. **Instruments of climate change governance**

Formal instruments	Economic instruments	Informal instruments
Regional development plans	Land-use taxes	Development concepts (local, regional)
Land-use plans	Soil-sealing charges	Development scenarios
Zoning plans	Water charges	Mission statements
Urban planning agreements	Tradable land-use rights	Area management (local, regional)
Plan approval procedures	Certificates	Networks
Environmental impact assessments	Climate standards	Aggregate liability indices
Strategic environmental audits	Incentive systems	Climate proofing
	Climate labels	Climate agencies
		Flood protection associations

Source: Frohlich, J. and J. Kieling (2013), "Conceptualising climate change governance", in: Knieling, J. and W. Leal Filho (eds.), "Climate change governance", *Climate Change Management*, pp. 9-26, Springer-Verlag, Berlin and Heidelberg, Germany, http://dx.doi.org/10.1007/978-3-642-29831-8_2.

The task of co-ordinating the Federal District, the State of Mexico and the municipal-level authorities is particularly challenging given the absence of a regulatory framework to guide inter-municipal climate change and environmental protection. The

experience of Portland's Climate Change Strategy[44] and the London Climate Change Partnership[45] suggests that a seamless co-ordination from the outset, across and among governments, is critical for an effective implementation of climate adaptation strategies. Given the fragmented nature of the governance arrangements in the Valle de México (see Chapter 5), the CAMe constitutes an asset for better co-ordination and collaboration among the 6 central governments, the 225 municipalities and the 16 *delegaciones*. Meanwhile, it is essential to upgrade the institutional capacities of the commission. As a first step, the issue of funding needs to be accelerated so that the Executive Co-ordination has the necessary human capital and budgetary resources to finance research and co-ordination projects and assist local governments in capacity building. The commission has a large portfolio of topics to deal with, from air quality control to waste management, water treatment and forest protection. It needs the financial resources and qualified personnel. Secondly, the commission will require the support of all state Ministries (*secretarías*) of Environment and that of SEMARNAT and SEDATU at national level, to ensure that they all share the same vision. Although the commission has no implementation responsibilities, it should be given the role of supervising and assessing the agreed environmental strategies. These assessments should be used to benchmark progress and to give advisory assistance to governments that lag behind. Members of the Organ of Government should meet periodically to show not only political support for the commission but to follow up on decisions taken and agreements reached, and look for alternatives to improve their work and that of the commission.

Reconciling environmental objectives with economic growth

Mexico has made green growth, and in particular sustainable water management and the reduction of carbon emissions, key national priorities (see Government of Mexico, 2013). The aim is to promote growth that preserves natural resources while encouraging competitiveness and employment.[46] For Mexico in general, and for authorities in the Valle de México in particular, focusing on green growth is a way to tackle poverty, provide sustainable livelihoods and job creation; mobilise resources and reduce the burden on public finances while improving the environment; reduce vulnerability to environmental disasters; and encourage new growth and job opportunities. Mobility, construction, water management and air quality are beginning to be managed with a green growth perspective, but these efforts are still somewhat isolated.

An explicit green growth agenda underpinned by pro-growth factors is needed

The Valle de México requires a concrete metropolitan green growth strategy that stimulates growth through urban activities that reduce either: 1) negative environmental externalities, such as air pollution and CO_2 emissions; or 2) the consumption of natural resources and environmental services, including water, energy and underdeveloped land (OECD, 2013b). Policies to reduce environmental impact can only be sustained over the long term if they generate wealth.[47] Although green growth does not explicitly focus on social equity, improving the environmental performance of the Valle de México need not be at the expense of social progress. Green growth policies have the potential to benefit the poorest and most vulnerable indirectly, but authorities must design green growth policies that maximise benefits and minimise costs for the poorer groups. Some cities, for instance, Toronto, with its green jobs programme, and Chicago, with its Green Jobs for All initiative, have explicitly pursued equity objectives alongside environmental and economic goals, by focusing on jobs.

The Valle de México needs to be prepared for the new jobs that will be demanded in a green-oriented economy. The availability of skilled and trained people will facilitate the development of a more dynamic economy. Training and education need to be at the top of the national and local authorities' agenda, ensuring that vulnerable groups are not left behind. Local authorities need to capitalise on the recently approved national education reforms to ensure that there is a strong cluster of linked competencies in firms, universities and the workforce, to promote job creation and innovation with a green orientation. Skill creation for new jobs, as well as training to upgrade old jobs, can be more efficiently organised by pooling the learning resources of educational institutions and industries in the metropolitan area. All major national universities and technology institutes are based in the Valle de México, and this asset could be exploited to upgrade the skills of the labour force through partnerships between universities, enterprises and the public sector. At the same time, the universities in the metropolitan zone need to pay greater attention to the educational needs of the metropolitan workforce. For example, in the Chicago Tri-State Region, a number of regional or applied universities are actively promoting economic development and research. Universities like the University of Illinois at Chicago, Northern Illinois University and local private universities have explicit regional engagement missions and more applied academic programmes to help match curricula and research with regional needs (OECD, 2012b).

Partnering with the private sector is a critical step in transitioning to the green economy. National and local authorities will have to work closely with the private sector to identify their needs and enhance local efforts to develop skills. Linking local training initiatives with the overall economic development strategy and to an explicit metropolitan green growth strategy can help assess local needs. Particular focus should be placed on small- and medium-sized firms, which, compared to large companies, have greater difficulty in providing in-house training to employees.

Investments in infrastructure should have a green orientation

High-quality infrastructure and services are accepted as being vital to a strong economy. Upgrading transport infrastructure, for instance, can shorten travel times, which in turn can affect property prices and economic rents and influence decision making of households (in residential location and patterns of consumption) and firms (production location, access to markets and investment decisions) (Hammer et al., 2011).

Some large-scale urban infrastructure programmes offer great potential for greening dirty economic sectors, and sometimes, re-employing displaced workers or creating new jobs, as well as generating new growth. The construction of the New Mexico City International Airport (NAICM) and its operation offer several possibilities for green growth (Box 4.9). If the Master Plan for the construction of the new airport is followed, the new terminal and its surrounding environment will be environmentally sustainable.[48] The construction of the new airport could also include measures to ensure using green technology and environmentally friendly procedures through green procurement. A condition for granting construction contracts should be the use of clean and green materials. The new airport offers the possibility of generating new growth through the renewable energy sector (CO_2 capture and storage; and solar panels on airport buildings, etc.), an area that needs to be further developed in Mexico.

Box 4.9. Greening the construction and operation of the New Mexico City International Airport

The construction of the New Mexico City International Airport (NAICM) requires an eco-friendly airport planning approach. The Master Plan provides for the NAICM to have a positive impact on the quality of life and the environment in the Valle de México. It includes several green initiatives that cover the construction and operation of the airport, aimed at obtaining Leadership in Energy and Environmental Design (LEED) international certification. The use of renewable energy, water treatment and reuse, rainwater collection, use of recycled materials with low emissions, and the use of biogas for electricity production are some examples. An integrated management hydrology is expected to rehabilitate the area of the former Lake Texcoco. However, to ensure that a green NAICM does not only refer to the airport infrastructure but also to its operation in relation to the environment, Mexican authorities may consider the following points:

- Regularly conduct an environmental impact assessment associated with aviation activity that detects environmental consequences and control measures. The idea is to assess and manage all possible potential environmental impacts the NAICM may encounter and consider alternatives to address them.
- Integrate the NAICM into the resilience strategy for the Valle de México. This will require analysis of climate change impact scenarios in which the existence of the airport may alter environmental outcomes, such as flooding. The participation of the state-level governments in this exercise will be essential.
- Define guidelines on infrastructure for airport environmental management. All airport staff and stakeholders should be trained in the environmental management requirements. Authorities may also consider adopting a collaborative environmental management programme to ensure that all stakeholders have the same information and the vision of a more efficient, pollution-free and environmentally sound airport environment.
- Align land-use planning and administration with the construction and operation of the airport. Urban planning should cover the airport's construction and operation and its related activities. In Singapore, the construction of Changi Airport was in line with urban planning, land-use planning and environmental regulations, and required that the whole airport area be planted with lush vegetation.
- Include climate change resilience and adaptation strategies in the construction and operation plans of the airport. The underlying issue is to show how the airport can achieve national and sub-national objectives on climate change, such as reducing GHG emissions while encouraging economic development.
- Define and implement a mass public transport strategy, so as not to rely on road transport (see Chapter 3). This would reduce the motor vehicle traffic and emissions from the airport. In the United Kingdom, airport construction or expansion permits are granted only after plans for mass public transport have been defined.
- Define how the airport will contribute to the air quality improvement objectives of ProAire. A clear strategy for reducing the emissions of the airport activity should be agreed on. Following the example of Hong Kong International Airport and Warwick Airport in the United Kingdom, a Clean Air Charter could be signed by all stakeholders involved in airport operations.
- Implement a waste management system for collection, segregation, storage and safe disposal of waste. For example, both Charles de Gaulle Airport and Orly Airport in Paris recycle at least 30% of waste.

Box 4.9. **Greening the construction and operation of the New Mexico City International Airport** (*continued*)

- Undertake extensive flora and fauna studies to determine the biodiversity values within the airport boundaries. Flora and fauna could be rehabilitated with the help of federal and state environmental authorities and NGOs. Appropriate landscaping may also be considered by, for example, planting trees around the bodies of water. The construction of a dedicated pipeline network around the airport could irrigate the area with treated water, a strategy implemented at the Indira Gandhi International Airport in Delhi, India, and Charles de Gaulle Airport in Paris.
- Noise reduction should be central to the airport management, and introducing noise mitigation measures should be considered. These might include restricting the operation of old aircraft, the continuous descent approach, avoiding aircraft overflights in densely populated areas, etc.

Overcoming barriers to innovation is essential to shift towards green growth

Innovation serves as an important bridge to the green economy. National and local authorities in the Valle de México will need to ensure that barriers to innovation, such as lack of funding, barriers to early-stage commercial development and demand-side policies, are dealt with. In Mexico, the National Development Plan 2013-2018 acknowledges the need for more funding for research. However, it is still unclear whether sub-national levels of government also consider it a priority and how they intend to promote it. Research on generic or general-purpose technologies, such as green chemistry, biotechnologies, etc., have not kept pace with growing environmental challenges. Transformative innovation in the green technology sector often results from spillover effects from other sectors. For example, enabling technologies (ICT and nanotechnologies) can significantly decrease the cost and increase the environmental efficiency of new infrastructure and network investments. In France, for example, the Paris suburb of Issy-les-Moulineaux, by providing superior broadband infrastructure, a business-friendly climate and innovative e-services, has managed in less than a decade to radically change its industrial structure, reducing local unemployment to virtually zero (Hammer et al., 2011). Mexican authorities in the Valle de México could fund research in the form of R&D tax credits or subsidy support.

State-level governments in the Valle de México could also support green innovation by targeting barriers to its early-stage commercial development, including access to finance. Mexico has a relatively immature market for green innovation. The challenge for Mexican authorities, as it is for many OECD countries, is that the dominance of existing design in energy and transport markets can create entry barriers for new technologies, due to the high fixed costs of developing new infrastructure. Authorities in the Valle de México could strengthen green innovation from the demand side through policies that incorporate environmental conditions, such as government standards and labelling. Building partnerships with academia could help set up eco-innovation clusters. Universities can facilitate local knowledge exchange and become effective pipelines of information exchange with national and global markets.

The Federal District and the State of Mexico could consider the creation of a metropolitan innovation system for the Valle de México through inter-state and inter-municipal dialogue. This would reduce zero-sum game competition and increase

trust, develop a common approach to optimising the innovation-driven growth potential of the metropolitan area in the long term and enhance co-operation. The CAMe is in a key position to facilitate this dialogue. Producing relevant data on innovation at the metropolitan scale would be critical to help raise awareness of regional imperatives. The CAMe could be given the mandate to collect data and indicators from existing research centres, with the goal of providing strong evidence for future metropolitan green growth initiatives. It could link up with state, municipal and federal authorities responsible for the policies and programmes that affect economic development, workforce development, innovation, green growth capacity, and transport and logistics in the metropolitan zone. Authorities in the ZMVM would also need to critically review the economic development programmes for cost-neutral innovation-driven growth. This would help prioritise among different investments to make strategic choices with a common approach and, if needed, reorient public expenditure towards more durable sources of economic development for the metropolitan zone. Public procurement and regulation, cost-neutral to public budgets, are other potential tools to spur innovation.

Encouraging innovation could also be promoted by a joint strategic environmental assessment. Authorities in the ZMVM may wish to review the Scottish Environmental Assessment Act, which establishes the modalities for conducting an environmental assessment. It defines an environmental assessment as the preparation of an environmental report through public consultations whose results must be taken into account in decision making.[49] The Canadian Environmental Assessment Agency is also an interesting example, which not only ensures the timely completion of environmental assessments, but promotes co-ordination and co-operation between federal and provincial governments, communication with aboriginal people and ensures opportunities for a meaningful public participation during an environmental assessment.[50] A joint strategic environmental assessment would provide authorities in the Valle de México with valuable information on whether apparently green policies and programmes, such as subsidies, might have unintended consequences. It would also be useful in promoting good governance for green growth. Local environmental policies and programmes need to be assessed in terms of effectiveness (compliance and enforcement) and impact.

The use of market incentives for environmental policy could be strengthened

OECD (2013c) has found that Mexico has made progress in using market-based instruments other than taxes to create incentives for using natural resources more efficiently and reducing pollution and environmental damage. These instruments generally take the form of subsidies. Fees have been implemented only in the area of water and, to a lesser extent, biodiversity management.

The federal and state-level governments in the Valle de México could reward environmentally sound goods and activities. Mexico has primarily used subsidy-based instruments to reward the purchase of supposedly more environmentally friendly goods. These have included soft loans and tax deductions for businesses' environment-related investment, tax credits for scrapping old buses, and subsidies to replace old home electric appliances and loans to low-income households to purchase energy- and water-efficient houses or for home retrofitting (ECOCASA, *hipoteca verde*). All these mechanisms can encourage businesses and consumers to make more environmentally friendly purchases. However, they come at a cost to the budget and discriminate against households and businesses that cannot afford such purchases and investments. From an environmental perspective, these measures are generally less efficient than instruments such as taxes that directly incorporate the cost of environmental damage into market prices. By targeting a

limited range of cleaner products or activities, subsidy-based measures encourage firms and consumers to adopt the subsidies even when other options are more effective (OECD, 2013b).

Authorities in the Valle de México could also improve air quality, reduce traffic, increase revenue and green the economy by limiting the incentives to vehicle ownership and use, particularly company cars. Mexico is one of the few countries where company cars are fully exempt from employee income tax, which encourages employers to offer their employees income in this way. About one-third of all newly registered cars in 2009-11 were company cars, a higher share than in many OECD countries, including the United States (OECD, 2013c). Fuel expenses are deductible from corporate income up to MXN 250 (USD 16.5). Thus, employers have almost no incentive to limit the use of company cars by employees, and they in turn, having virtually no additional costs linked to car use, have no incentive to drive less or more efficiently. Some form of local taxation could be imposed on the ownership and use of company cars. Free parking provided by employers is also a non-taxed benefit in kind. In contrast, commuting expenses paid by employers are part of employees' taxable income, though with some tax advantage when public transport is used. In general, this mix of incentives encourages driving to work (mainly at rush hour and to/from particularly congested locations), exacerbating congestion, the risk of accidents and environmental problems. Including parking spaces in taxable benefits would remove this incentive, and meanwhile, efficient and reliable alternatives on public transport should be provided.

Local governments' institutional capacity for green growth needs to be upgraded …

The institutional capacity of state but above all municipal governments in the ZMVM needs to be substantially reinforced. This would involve sources of funding and building a professionalised public workforce with the right skills and competences (see Chapter 5). In Japan, the city of Kitakyushu is building green growth capacity by requiring staff to regularly transfer between administrative offices focused on economic development and those centred on environmental affairs. This policy is an explicit effort to build "green growth personnel" who understand inter-sectoral linkages and trade-offs between short-term economic imperatives and long-term sustainability goals (OECD, 2013b).

State- and municipal-level authorities in the Valle de México need to further explore mechanisms to mobilise public and private funds for promoting inclusive green growth. Many urban revenue sources can be designed to either stimulate or discourage green growth in the metropolitan zone. For example, well-designed property taxes and development fees can tackle urban sprawl and raise money for funding green infrastructure. In addition, private financing can be attracted to fill the funding gap for many urban green infrastructure projects. Some of the measures that can be adopted are: 1) real estate developer charges and fees to pay for the infrastructure needed to connect new development to existing infrastructure, and discourage urban sprawl; 2) land-value capture taxes aimed at seizing part of the value increases of real estate due to new nearby infrastructure development (this is the case in the redevelopment of Presidente Mazaryk Avenue in Mexico City); 3) public-private partnerships (PPPs) which transfer the long-term risk to the private sector (capacity to manage PPPs, however, needs to be developed); and 4) the use of loans, bonds and carbon finance to attract private investment.

Authorities in the Valle de México may also wish to promote local good practices in building resilience and mitigating and adapting to climate change, as a way to enhance capacity. This is a task that may be undertaken by the CAMe. Experience shows that when initiatives started in a locality are promoted to other areas in the same region, their chances of being adopted and emulated are higher. The experience of the City of London suggests that emerging good practices need to be monitored, assessed and promoted, along with the necessary toolkit for successful implementation (London21, 2008). In addition, the Valle de México could institutionalise climate change preparation planning by, for instance, establishing a multi-bureau or -department adaptive management co-ordination team, to review emergent trends and regulation and share information. It will also be critical to strengthen emergency management capacity to respond to natural emergencies such as heavy rain, floods or heat waves (OECD, 2013c). Valle de México authorities could also consider means to improve monitoring, evaluate the effectiveness of climate change preparation actions and advance new research to support climate change preparation efforts, as practiced in Portland and Toronto. Building databases and filling data gaps, supporting research and monitoring trends in natural developments are some options for building capacity.

To further enhance capacity, state-level authorities in the Valle de México could also fund research. Mexico City's climate action programme already includes research and development as a strategy for climate change action, but giving it a metropolitan approach would have a more relevant effect. For example, authorities in the Valle de Mexico can emulate the model of the Brainport Eindhoven Region in the Netherlands, where the municipality of Eindhoven and the Eindhoven Metropolitan Region have been supporting research and technology development to contribute to a safe, green, sustainable economic development and ensure the region's international economic competitiveness.[51] Similarly, the San Francisco Metropolitan Transport Commission finances innovative projects aimed at reducing GHG emissions, such as fleet-oriented vehicle programmes, to encourage housing construction in areas well-served by public transport.[52] The CAMe and RTP could develop similar investment projects.

… and the federal government should support them in pursuing green growth objectives

One way the federal government can support green growth, not only in the Valle de México but nation-wide, is by incorporating green growth and sustainable development policies into structural reform agendas. It can define the overall vision and strategy for inclusive green growth, so as to frame national and sub-national policy reforms as positive long-term goals. Another option is to provide financial or technical support for setting targets and designing monitoring mechanisms for green growth policies. Price signals and standards could be set up through carbon taxes or other pricing mechanisms. The federal government could also help in greening typical local taxes, such as the property tax, and assisting in making better use of service charges to strengthen the budgets of local governments, which are responsible for providing basic environmental services (OECD, 2013c). The federal government could also review national policies' impact on local incentives to encourage green growth to identify and eliminate perverse incentives, for example in the housing sector. It can also encourage infrastructure investment in line with sustainable development and green goals.

It is critical that federal policies ensure policy coherence across levels of government. The greener the national framework, the easier it will be to address specific challenges in the ZMVM, and to ensure coherence and consistency between national and local policies. The national government should also ensure the adoption of a holistic approach for a green growth agenda, based on the objectives set in the National Development Programme 2013-2018. The experience of OECD countries suggests that efforts to encourage urban green growth may not always be equitable. These concerns should be addressed through national policies, particularly the tax and benefit system, rather than trying to ensure that individual policy measures fulfil both environmental and equity objectives. Furthermore, the federal government should ensure that sophisticated policy instruments such as those related to green growth be grouped within a simple policy package. The experience of OECD countries shows that an overly complex system of regulations, incentives and taxes makes impact assessment harder and raises the risk of unintended effects or perverse incentives.

The federal government may also be of assistance to local governments in the Valle de México by helping them to conduct a public environmental expenditure review. The aim is to examine, together with the federal Ministry of Finance and Public Credit (Secretaría de Hacienda y Crédito Público, SHCP), local governments' resource allocations within and among sectors. The efficiency and effectiveness of those allocations can then be assessed in the context of environmental priorities, while maintaining fiscal prudence. The final goal is to assist governments to redistribute spending to institutions responsible for environmental priorities, and on long-term goals, thereby increasing environmental budgets. This review would be useful for identifying, quantifying and maximising the public revenue potential of under-priced natural resources, such as water. The data and insights obtained from the review could help in designing policy reforms, government budgets and investment projects. In Mexico's political context, however, the national government can only intervene at the request of local governments if there is not enough technical capacity. A memorandum of understanding between federal and local authorities for carrying out the review could be signed and a review panel established.

Conclusion

The Valle de México faces growing demand and low supply of drinking water, poor air quality, and lacks an efficient waste management system. To a large extent, the environmental problems are the product of poor urban strategic planning and its dissociation from environmental protection, and the administrative fragmentation and particularities of the political system. To address the specific urban environmental challenges, environmental issues could be integrated in all urban planning and development projects, and a metropolitan resilience strategy formulated. The water sector should focus on ensuring a sustainable provision of water; improving air quality by enhancing co-operation with the transport and construction sectors. A metropolitan waste management strategy is needed to boost air quality improvement efforts, and avoid polluting water reservoirs and soil. Better urban governance arrangements can facilitate the integration of environmental and urban planning. Thinking in metropolitan terms and facilitating inter-municipal co-operation on key environmental objectives are key issues for consideration. Environmental protection should also be regarded as an economic asset, and adopting a green growth approach to urban-environmental planning is critical in promoting economic development. The recommendations made in this review build on existing experience in Mexico and OECD countries. The authorities in the

Valle de México have been working on several of these issues for a long time, and now need to work as a team, building on each other's experience, to work towards a common goal.

Notes

1. Only a small part of the system of lakes, the southern Lake Xochimilco, was freshwater. Most of the system was formed by saline lakes. During the rainy season, the lakes frequently expanded into a single body of water. Floods – sometimes lasting for several years – led to efforts to limit the extent of the lakes. In Aztec times, dykes separated freshwater and saltwater parts of the system of lakes and protected areas of the city from fluctuations in water levels. At the beginning of the 17th century, under Spanish rule, it was decided to drain the lakes (see Alcocer and Williams, 1996, for details).
2. Data from desinventar.net (accessed 17 April 2015).
3. Neighbourhood in this case refers to AGEB (*áreas geográfico estadísticas básicas*).
4. MXN to USD conversion is based on average 2014 exchange rate.
5. For further information see: Government of Mexico (2013); Government of the Federal District (2013); Government of the State of Mexico (2011).
6. See Soto Montes de Oca (2007) for details, though wells as deep as 105 metres were already dug in 1847 (Jimenez, 2014).
3. See the recently released images by the European Space Agency (2014).
8. See: http://cuidarelagua.df.gob.mx/costo.html for details.
9. For further details, see Government of the Federal District (2013).
4. See: www.sacmex.df.gob.mx/sacmex/doc/3_atencion_a_usuarios/tarifas/tandeo_2015.pdf for details. According to the government of the Federal District, more than 1.5 million residents receive water through the *tandeo* system; and 180 000 people do not have networks that connect the houses to the main supply system, because they are located in a non-authorised area (Ciudad de México, 2013).
5. See: www.conagua.gob.mx/CONAGUA07/Temas/CALIDADAGUA.pdf for current values.
6. See e.g. CONAGUA (2014a).
7. Surface water is treated more thoroughly than groundwater. Groundwater is treated with chlorine before being injected into the network, while surface water is treated by alum coagulation and sedimentation in addition to chlorination (Jiménez, 2014).
8. Norm NOM-127-SSA1-1994. See CONAGUA (2009) for details.
9. Ibid.

16. Article 129 of the Código Financiero del Estado de México y Municipios sets out the municipalities' rights in adjusting the state's tariffs specified in Article 130ff.

10. For further information, see: www.conagua.gob.mx/tarifas.

11. There were 1 358 134 registered users in 2012 (SACMEX, 2013).

12. 2013 data from CONAGUA (2014a) and 2012 data from SACMEX (2013).

13. See CONAGUA (2010) for CONAGUA's budget and 2012 data from SACMEX (2013) for SACMEX's budget.

14. For further information, see: www2.inecc.gob.mx/publicaciones/libros/394/cap4.pdf; and http://biophysics.sbg.ac.at/mexico/air.htm.

22. See: www.inegi.org.mx/est/contenidos/proyectos/registros/economicas/vehiculos/default.aspx.

23. See: http://midiariourbano.blogspot.fr/2012/02/diagnostico-de-la-basura-en-el-distrito.html.

24. The Environmental Commission for the Megalopolis (CAMe) is part of the wide array of efforts Mexican authorities have used to co-ordinate work on air quality management since the 1990s.

25. For further information, see www.df.gob.mx. However, there is a growing body of literature that suggests that *Hoy No Circula* has not had the desired effects and that this has contributed to more emissions and congestion. See, for example: Gallego, Montero and Salas (2013); Riveros Rotgé (2009); and Eskeland and Feyzioglu (1995).

26. Mexico City is reportedly also planning to build more second decks in urban highways. This decision is surprising, since there is wide empirical evidence that shows that building more roads increases congestion. See, for example: www.wired.com/2014/06/wuwt-traffic-induced-demand; www.vtpi.org/gentraf.pdf; and www.redalyc.org/articulo.oa?id=31200104.

27. In Mexico's administration, the bodies called *desconcentrados* refer to bodies subordinated to an organ of the central public administration. Their competences are regional and thematic, and determined by law. They do not have legal personality or their own assets. In contrast, a decentralised (*descentralizado*) body has legal personality, autonomy in decision making and its own assets.

28. The council's website shows significant activity in 2010 and 2011 but has not been updated since then. See: http://cuencavalledemexico.com.

29. The estimated responses are showing the average response. How much consumers will ultimately reduce demand is likely to differ based on their affluence and initial level of consumption.

30. The main obstacle for vertical co-ordination in water policy making cited in an OECD survey on water governance (2010-11) for Mexico was unstable or insufficient revenues. See OECD (2012c) for details.

31. See: www.agua.unam.mx/sacmex/assets/docs/granreto_sacmex.pdf and SACMEX (2013) for details.

32. See Fuentes (2011) and the cited literature.

33. Average consumption is 166.89 litres per day across 30 Latin American water service providers (ADERASA, 2012).

34. For further information see: www.conanp.gob.mx/acciones/programa.php.

35. See WHO (2003) for a detailed discussion.

36. Information provided by the Ministry of Environment of Mexico City (SEDEMA).

37. In 2015, the RTP expects to acquire 220 natural gas buses with environmentally friendly technology.

38. For an in-depth discussion on the toolbox for urban air quality management, see UNEP (2005).

39. For further information, see: www.iadb.org/en/topics/climate-change/mexico-ecocasa-ctf,9899.html.

40. For further information, see: http://portal.infonavit.org.mx/wps/wcm/connect/infonavit/trabajadores/saber+para+decidir/cuido_mi_casa/ahorro+y+cuido+el+medio+ambiente.

41. For further information, see The Rockefeller Foundation/Arup (2014).

42. For further information see: www.portlandoregon.gov/bps/climate.

43. For further information see: www.london21.org/uploads/files/london21/Newsletter.

44. For further information see: www.portlandoregon.gov/bps/climate.

45. For further information see: http://climatelondon.org.uk/lccp.

46. Mexico has also been a champion of inclusive green growth. In 2012, the Mexican presidency of the G20 introduced inclusive green growth as a cross-cutting priority on the G20 development agenda.

47. For an in-depth discussion, see Hammer et al. (2011).

48. The current Master Plan for the new airport for Mexico City includes several measures that would make it environmentally sustainable, such as installing better waste capture facilities, recycling water, generating energy through biogas, the establishment of parks and water reservoirs, etc.

49. For further information, see: www.gov.scot/Home.

50. For further information, see: Parliament of Canada www.parl.gc.ca/HousePublications/Publication and Canadian Environmental Assessment Agency www.ceaa-acee.gc.ca.

51. For further information, see: www.brainport.nl/en/work/brainport-eindhoven-region-makes-a-name-for-itself-in-the-world.

52. For further information, see: www.mtc.ca.gov.

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