THE CASE FOR INTEGRATED AIR QUALITY AND CLIMATE CHANGE POLICIES

Tirusha Thambiran[1,2*] and Roseanne D. Diab[2]

* Author for correspondence: tthambiran@csir.co.za

[1]CSIR Natural Resources and the Environment, PO Box 17001, Congella 4013, South Africa.
Telephone: +27 31 2422368
Fax: +27 31 261 2509

[2]School of Environmental Sciences, University of KwaZulu-Natal, Westville Campus, Private Bag X 54001, Durban 4000, South Africa.

Abstract

The relationship between air quality and climate change provides a scientific basis for developing integrative policies. Local governments in developing countries are expected to reap significant benefits from incorporating climate change concerns into air quality policies. In Africa, South Africa is also one of the few countries on the continent to have developed robust air quality legislation. South African municipalities or local governments are required to develop and implement air quality management plans (AQMPS), which present opportunities to integrate climate change considerations. The extent to which cities are currently incorporating climate change concerns into existing air pollution strategies, and the opportunities for improved integration of these two issues, and actions to support the implementation thereof, are presented in this paper using the city of Durban as a case study. The results from this case study suggest that in the short-to medium-term, local AQMPs can be used to support climate change mitigation. These outcomes could be relevant to other countries that use a similar approach to air quality management and require local AQMPs to be developed.

Keywords: *air quality management; climate change mitigation, integrated policies, Durban*

1. Introduction

Air quality and climate change are inextricably linked, with complex interactions and linkages. This relationship provides a scientific basis for developing integrative policies that derive multiple benefits for simultaneously improving air quality and addressing climate change. As the focal points of expected growth in polluting activities (Fenger, 2008), cities in developing countries have the potential to act as 'engines of environmental policy' (Granberg and Elander, 2007, 439), and to drive innovative policy responses to climate change, whilst simultaneously addressing urgent air pollution challenges. Based on recent climate negotiations, early policy development and planning for climate change within air quality management (AQM) policies may position cities to capitalise on opportunities to reduce baseline greenhouse gas (GHG) emissions, lead in future efforts related to the carbon trading market, and thus contribute toward creating low carbon, resilient societies.

On the African continent, South Africa is one of the few countries to have developed robust AQM legislation and air quality monitoring programmes (APINA, 2010). The South African National Environmental Management: Air Quality Act (Act No.39 of 2004) (the AQA) ensures that cities are well capacitated with authority over air quality through the development of local air quality management plans (AQMPs). Presently, AQM proceeds through the implementation of the most cost-effective actions to reduce air pollution, with the costs of interventions generally increasing until targets for emission reductions are achieved. Opportunities to use air quality interventions in an innovative manner to contribute toward creating low carbon, resilient communities are mostly overlooked as the AQA does not provide guidance for the integration of climate change concerns into local AQMPs. South Africa is ideally poised to develop holistic AQMPs that incorporate climate change considerations. This will not only set an example for many developed countries with similar AQM structures but may also provide some guidance for other African countries who are still developing their air quality policies.

The purpose of this paper is to discuss the role that local AQMPs in South Africa can play in supporting climate change mitigation and adaptation endeavours, using the city of Durban as a case study. The extent to which the city currently incorporates climate change concerns into its existing AQMP, and the opportunities for improved integration of these two issues is presented in Section 2 of this paper. In Section 3, key recommendations for decision-makers to consider in facilitating the inclusion of climate change into local AQMPs are presented. Section 4 presents concluding remarks.

2. Case study of Durban

2.1 Background to air quality and climate change issues

Durban is located within the province of KwaZulu-Natal on the eastern seaboard of South Africa. It occupies ~1.4% of the total area of the province and has the largest port on the east coast of Africa. The city's economy is driven by manufacturing industries and tourism, comprising 9% of South Africa's Gross Domestic Product (GDP) and represents the third largest economy in the country (EM, 2010). The economy has been shaped principally by an energy sector that is dependent primarily on the use of the country's large coal reserves and liquid fuel imported as crude oil. The manner in which energy is generated and consumed is the source of many environmental challenges, including poor ambient air quality and high GHG emissions. Both of these are discussed in more detail below.

2.1.1 Air pollution

Durban has been characterised as consisting of numerous air pollution sources, primarily attributed to the combustion of fossil fuels at industries and in road transport. The AQMP developed in 2007 serves as the foundation to ensure that measures are implemented within these sectors to maintain ambient air quality levels that are acceptable for human health and ecosystems (EM, 2007a).

The city has a modern air quality monitoring network, consisting of 11 air pollution stations. Annual averaged data from these continuous air quality monitoring stations indicate that the ambient air quality experienced in the city is generally within the South African standards for ambient air quality (Fig. 1).

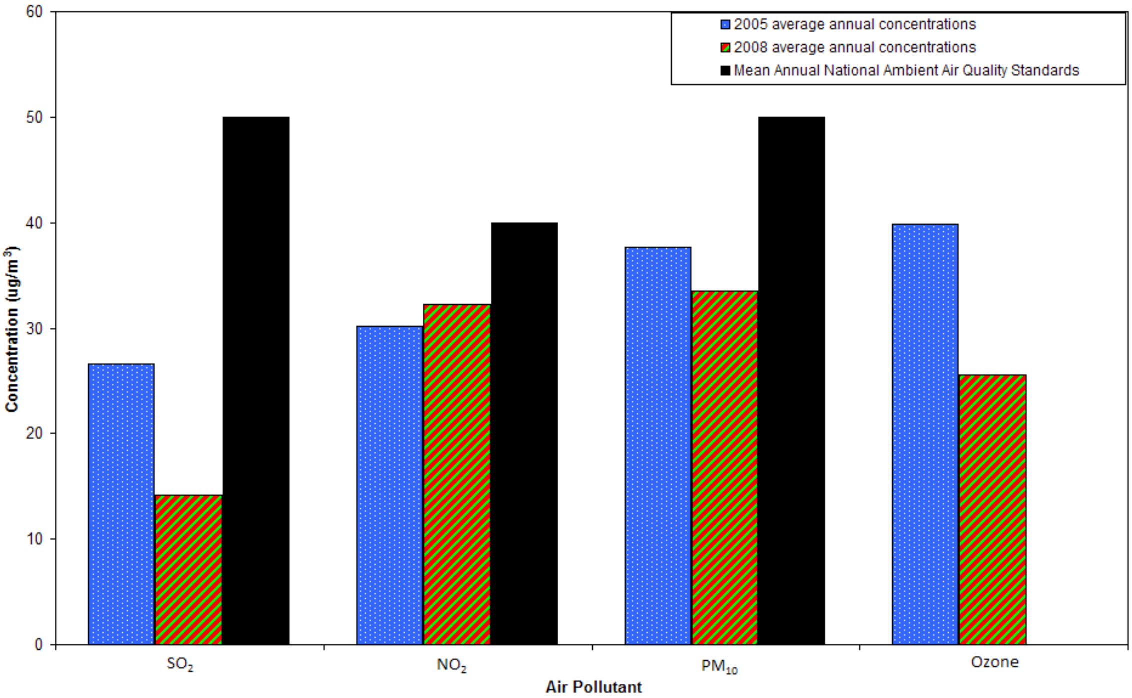

Figure 1: Average annual priority pollutant concentrations for 2005 (EM, 2005) and 2008 (EM, 2008) versus annual ambient air quality standards (SA, 2009). * There is no annual standard for ozone

Levels of average annual particulate matter (PM_{10}) and nitrogen dioxide (NO_2) shown in Figure 1 are indicative of the growing contribution of road transport emissions. Conformity with sulphur dioxide (SO_2) limits is primarily due to the impact of past industrial interventions focused on SO_2 emissions. Although these data indicate compliance in terms of mean annual standards, in recent years the 10-minute and hourly limits for ambient SO_2 have been exceeded (EM, 2008). These exceedances were primarily linked to industrial process upsets, flaring incidents and downtime of air pollution scrubbers in industries. The frequency of these exceedances has been a strong focus of the city and industries for reduction. In light of new minimum emission standards being implemented under the AQA, PM and NO_x emissions are also likely to be the focus of future AQM action plans.

2.1.2 Climate change

Climate change concerns have to date been dealt with separately from the AQMP with the majority of research focused on understanding the impacts of climate change on the city and the adaptation measures that will be required. This has been a priority as it has been estimated that in the future (2070 to 2100) the city will experience varied climate change impacts. These changes are likely to exacerbate the problems of the poorest communities, who are least likely to be able respond or adapt.

Two GHG emissions inventories have been developed for the years 2002 and 2005 (EM, 2003; EM, 2007b). The 2005 emissions inventory highlighted electricity production as the major contributor to emissions, followed by contributions from industries and road transport. It was also estimated that the direct combustion of fossil fuels (excluding electricity consumption) in the road transport and industrial sectors were cumulatively responsible for ~46 % of the total GHG emissions.

On a per capita basis, the GHG emissions of Durban are lower than those of other cities with similar populations (Table 1). The higher emissions per capita for these cities can be attributed to various factors based on the characteristics of the city, including affluence and the sources of energy, as well as the methodologies used for developing the inventories.

In the case of Durban, many sources of emissions were not covered in the GHG inventory. These include the direct and fugitive contributions from the industrial sector, emissions related to shipping activities, and natural sources of emissions. In addition, estimates of road transport emissions were based on fuel sales and further, no assessment of emissions related to the life-cycle of goods manufactured and used in the city was made.

Table 1: Comparison of Durban's per capita emissions to other cities

City	Year of Inventory	Population	Carbon dioxide equivalent (CO_2-eq) estimates (M tonnes) per annum	Per capita emissions (tonnes/capita)
Athens	2005	3 989 000	41.47 [a]	10.40
Frankfurt	2005	3 778 124	51.61[a]	13.66
Hamburg	2005	4 259 670	41.52[a]	9.747
Bangkok	2005	5 6 58 953	60.44[a]	10.68
Cape Town	2006	3 497 097	40.43[a]	8.65
Durban	2005	3 161 844	23[b]	7.27

(Sources of data: [a] Kennedy *et al*., 2009; [b] EM, 2007*b*)

2.2 Climate change considerations and the AQMP

It has been argued that climate change considerations can potentially be included throughout the development and implementation of AQMPs in South Africa (Thambiran and Diab, 2010a), thus providing a platform to develop integrative policy responses to climate change. However, internationally, it has been shown that whilst local authorities may have the potential to promote the adoption of climate change considerations through this control of critical functions and existing policies, there have been many barriers to overcome. These range from a lack of awareness of opportunities, competing priorities and a lack of community/political will to act (Burch, 2009).

In the case of Durban, climate change and air quality issues are dealt with separately. Opportunities to use air quality interventions innovatively to address GHG emissions are therefore mostly overlooked. The opportunities for the city to start taking cognisance of the complex atmospheric interactions and linkages that exist between these two issues (Fig. 2) are discussed further in this section.

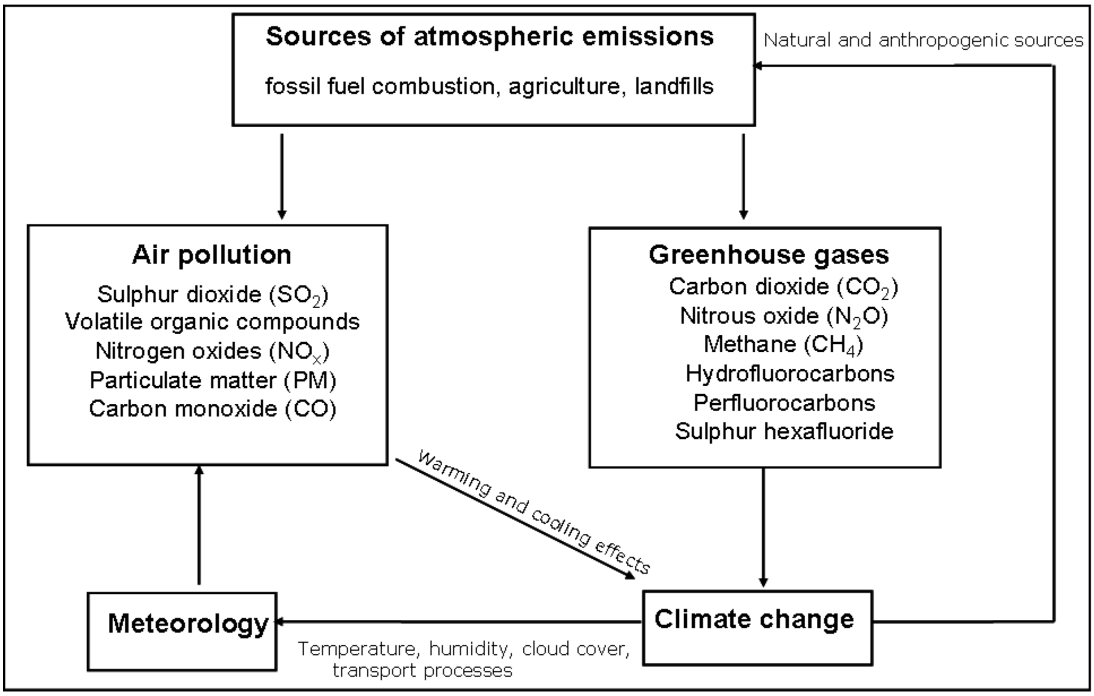

Figure 2: Summary of the linkages and interactions between climate change and air quality

2.2.1 Atmospheric emission reductions

Climate change and air quality considerations share common sources of emissions, thus interventions in these areas can simultaneously affect more than one air pollutant. A measure targeted at reducing emissions of a particular pollutant, might result in increases (trade-offs) or decreases (synergies or co-benefits) in the emissions of other pollutants. The combustion of fossil fuels within the industrial and road transportation sectors in the city is one of the most significant contributors to air pollution and GHG emissions. Both these sectors are prioritised for intervention in the AQMP, with no air pollution control measures currently being implemented within the road transport sector. There are no interventions within either of these sectors that are directly targeted at reducing GHG emissions.

In previous work by the authors (Thambiran and Diab, 2010b; 2011), emission inventories for 2008 for the industrial and road transport sectors in the city were developed. It was found that in 2008 the contribution to GHG emissions from these sectors increased by ~10% compared to 2005. The emissions inventories were further used to characterise how the different components that contribute toward atmospheric emissions in these sectors are related and how they could potentially be manipulated to achieve co-benefits. In this section, the outputs of an analysis of co-benefits are considered qualitatively within the context of possible impacts for other key priorities in the city.

2.2.1.1 The industrial sector

The industrial sector in Durban has been regulated up until 2010 by the Atmospheric Pollution Prevention Act (Act No. 45 of 1965) (the APPA), with many of the major industries being required by the local government to adopt more stringent emission standards as part of a set of measures to improve ambient air quality in the south of the city. In Thambiran and Diab (2010b), these air pollution interventions were considered in terms of their impacts on GHG emissions. It was found that the local government has required the implementation of numerous actions by industry to address air quality concerns and that these measures have been accompanied by varying synergies and trade-offs for climate change (Table 2). These include the increase in energy consumption due to the installation of air pollution cleaning devices and co-benefits from fuel switching. The impact on GHG emissions was not quantified or considered in the decision to implement these air quality control measures. Consequently in instances where interventions resulted in increases of GHG emissions, no actions were taken to offset the trade-offs for climate change.

Table 2: Impact of industrial interventions on atmospheric emissions and fossil fuel consumption within Durban (Thambiran and Diab, 2010*c*)

Industrial measure	Emissions increase	Emissions decrease	Impact on fossil fuel consumption
Installation of cleaning devises	CO_2 N_2O	SO_2 or PM or NO_x (depends on type of device used)	+
Modification to cleaning devices	CO_2	SO_2 or PM or NO_x	+
Change in fuel toward cleaner more efficient fuels		Reduces all related emissions from original fossil fuel source	-
Change in fuel toward use of renewable energy (biomass)	PM, NO_x	CO_2, SO_2	-
Change in fuel toward use of renewable energy (wind or solar)		Reduces all related emissions from original fossil fuel source	-
Change high sulphur coal to low sulphur coal		SO_2	No change. Increase if capacity requirements increase
Boiler modifications		Increases efficiency, reduces all air pollutants related to fossil fuel	-
Energy efficiency measures		Reduces all related emissions from fossil fuel source	-

+ (-) indicates an increase (decrease) in fossil fuel consumption

In addition to air quality improvements, industries have also implemented numerous measures aimed at reducing fossil fuel based energy consumption. Even though national energy policy has set renewable energy targets for the country (DME, 2003), there has been very little uptake of solar and wind resources within this sector. Instead interventions have predominantly focused on reducing grid-supplied electricity, through energy efficiency improvements, which has had no direct co-benefit for air quality improvements within the city.

These interventions were implemented as a result of cost-savings measures on the part of the industry, and demand-side management as required by the local government. Thus interventions employed for AQM and energy strategies are uncoordinated and therefore do not maximise opportunities for co-benefits.

The AQMP needs to have mechanisms in place to promote the adoption of air quality measures with co-benefits for GHG mitigation over those with trade-offs. Industrial activities that are regulated through atmospheric emission licenses (AELs) under the AQA present an opportunity to regulate co-benefits.

It is proposed that the quantification and consideration of the impact of air quality interventions for GHG emissions should be included as a condition for the issue of an AEL. Specifically, the impact of an air quality intervention on energy consumption and GHG emissions could be included when granting, reviewing and renewing an AEL. The expected increase or decrease in GHG emissions from an air quality measure should be quantified. If it results in increases in GHG emissions, measures that will be taken to offset this should be detailed in the application. Industrial energy audits may, for example, be used by industries to help identify other areas of operation where improvements to energy consumption could offset these increases. In cases of verifiable GHG emissions reductions, frameworks to adequately recognise and reward these efforts should be implemented through measures such as rebates of AEL application fees. Regulating air quality inventions that have favourable outcomes for GHG emissions through the AQA would require changes to national legislation. Alternatively, the local government could be proactive in this regard, by developing municipal by-laws requiring that industries prioritise those air quality interventions that are characterised by co-benefits.

However, there are numerous industries that are not categorised as listed activities and therefore do not require AELs. The cumulative contribution of fugitive and process emissions from these industries could have significant environmental consequences. Regulating air pollution and GHG emissions within non-listed industrial activities is an area that should be addressed across all spheres of government. Municipal by-laws could be established regulating the permissible emissions from non-listed industrial activities.

A combination of AELs and municipal by-laws can therefore be used to regulate the implementation of air quality control measures such that the trade-offs as shown in Table 2 are avoided or minimised. The industry's overall contribution to GHG emissions (within the city/nationally) and its emission intensity can be used to guide acceptable levels of trade-off from an air quality intervention measure.

2.2.1.2 The road transportation sector

Durban's public transport system consists of a rail network and fleet of buses. Due to concerns over safety and poor infrastructure, this system is underutilised. Consequently, there is an increasing dependence on privately-owned motor vehicles for passenger transport and the use of roads for freight transport. This sector is further dominated by the use of fossil fuels, with fuel sales in Durban increasing by 30% in 2008 compared to 2003 (Thambiran and Diab, 2011).

The road transport sector is considered to be a growing source of air pollution in the city. Unlike the industrial sector, regulations for the road transport sector are not as well developed within the country, with little incentive to ensure that motor vehicles are low contributors to air pollution. Many of the measures that are typically proposed to address air pollution within this sector have the potential to simultaneously impact on road safety and fossil fuel consumption as shown in Table 3.

Table 3: Impacts of road transport interventions on atmospheric emissions, fossil fuel consumption and road safety within Durban (Thambiran and Diab, 2010*c*)

Transport Intervention	**Impact on emissions**	**Impact on fossil fuel consumption**	**Impact on road safety**
Fleet renewal	Decrease of PM, NO_x (diesel vehicles) and CO (petrol vehicles). Impact on other pollutants depends on vehicle kilometres travelled (VKT)	- (improve fuel efficiency of newer vehicles) + (increase in VKT by newer vehicles)	-/+
Promotion of ultra low sulphur diesel	SO_2 decreases Reduction of ultrafine particles of black carbon	No impact	No impact
Reducing congestion	Decrease in all emissions due to lowering of VKT	-	+
Uptake of biodiesel	Decrease CO_2 Increase: PM, NO_x	-	No impact
Promotion of public transport over private motor vehicle use	Reducing VKT and all related emissions	-	+
Raise awareness of energy efficiency	Reducing VKT and all related emissions	-	+
Use of renewable energy sources (solar/water) in public transport	Decrease in all emissions	-	No impact
Increased efficiency of freight transport system	Reduction in all emissions related to road freight transport due to reduced VKT	-	+

+ (-) indicates an increase (decrease) in fossil fuel consumption; + (-) indicates benefits (no benefits) for road safety

The AQMP can play an important role in ensuring that interventions with multiple benefits are selected, by supporting and influencing interventions that target the types of vehicle technologies, fuel changes and road transport management measures that are implemented in the city. Further details are provided below.

Motor vehicle technologies and fuel changes

The age of the motor vehicle fleet within the city indicates that a large proportion of motor vehicles have been purchased prior to legislative controls on motor vehicle emissions in South Africa (Thambiran and Diab, 2011). Since it is widely recognised that it is difficult to retrofit older motor vehicles with catalytic converters and particulate diesel filters, it is necessary to try to reduce the numbers of these older motor vehicles on the road.

Notwithstanding this overall imperative, the replacement of older motor vehicles with new, less polluting ones may have varied impacts for air pollution depending on whether a petrol or diesel motor vehicle is purchased as shown in Table 3. Furthermore, as older motor vehicles are generally driven less, fleet renewal may result in an increase in vehicle kilometres travelled (VKT), thus potentially offsetting atmospheric emission reductions achieved through the use of improved pollution control technologies.

Policies aimed at influencing the types of motor vehicles purchased, specifically the split between petrol and diesel motor vehicles will therefore influence emissions from road transport. As such, AQM considerations should guide the types of motor vehicles promoted based on the likely overall impact on atmospheric emissions. Any fleet renewal campaign within the city will require an atmospheric emissions impact assessment and should be supported by measures to manage VKT (discussed later).

However, the ability of the city to actually influence the purchasing decisions of private motor vehicle owners may well be minimal and even if achievable, the impact would be confined to motor vehicles registered within its jurisdiction. A similar argument related to the city's limited ability to influence road transport users applies to making biodiesel or lower sulphur fuels available for use in road transport. The concern here is that even if fuel-based programmes are initiated by higher spheres of government, they may not result in co-beneficial outcomes within the city as the passenger motor vehicle fleet is still predominantly petrol-driven and there is a poor characterisation of the extent of import and export of fuel by motor vehicles driven on roads within the city.

Transport Demand Management (TDM)

TDM involves decreasing the actual number of motor vehicle trips and encouraging people to switch from private motor vehicles to public transport or non-motorised activities such as walking and cycling. Numerous barriers to successfully implementing TDM exist. Specifically, educating people about the financial and environmental effects of their private motor vehicle use is often not enough to encourage them to change modes of travel, as 'psychological dissonance' generally occurs (Poudenx, 2008). This means that while people may realise their impacts of driving, they choose to downplay the negative implications of their actions, so that they may continue with their normal behaviour patterns. Motor vehicles are also commonly seen as a sign of status, making it more difficult to get owners to give them up and switch to other forms of transport. Furthermore, as the current public transportation fleet is not the preferred mode of transport in the city (Thambiran and Diab, 2011), the provision of a service of perceived higher quality that operates with either clean vehicle technologies and fuels or renewable energy resources, presents a significant challenge.

In cases where such impediments to promoting the use of public and alternate forms of transport exist; taxes, user road pricing or congestion charging are seen as useful short-term interventions. Taxes or 'feebates' on yearly vehicle registrations are based on annual average mileages and are used to encourage fewer trips and reduce the amount that motor vehicles are driven (Greene *et al*., 2007). Disincentives to reduce traffic on congested roads have also been shown to be effective. A good example of a successful congestion charging policy is that of the Greater London Authority which led to a reduction in CO_2 emissions by 16% and generated over £93 million in revenue (EEA 2008).

AQM processes potentially have an important role to play in congestion charging, through assigning emissions to roads and determining impacts for ambient air quality. An important step to facilitate a better characterisation of emissions on roads is to improve the quality and frequency of road traffic counts. Improved spatial and temporal traffic count data, coupled with appropriate motor vehicle emission factors will allow for the determination of areas of significant emissions. Air quality monitoring data or dispersion modelling can be used to determine the impact on ambient air quality and the potential impacts for human health. This can be used as a basis for identifying those areas or roads that are in need of intervention and financial mechanisms to reduce travel in these areas may be considered. These measures however, will need to be supported by well-structured implementation plans and the development of efficient, safe and low polluting public transportation.

Heavy-duty vehicles

Durban's energy strategy and integrated transport plan both cite the need to encourage greater use of rail freight to reduce the demand for road freight transport. In an effort to promote greater use of the rail system the national government has issued plans to reduce the maximum truck axle limits from 9 tons to 8 tons (Cokayne, 2009). However, in the long-term the use of the rail system, which is primarily dependent on fossil-fuel generated electricity, is considered unsustainable.

Many of the problems with heavy-duty road freight transport are associated with operational problems related to overloading, motor vehicles being poorly maintained and exceeding the speed limit (Nordengen, 2009). The national road freight quality system requires permits for transporting goods, however, this system is poorly enforced and as such self-regulation of the heavy-duty vehicles used for freight transport is growing. A national standard for self-regulation within the heavy-duty motor transport fleet is under development. Many of the principles that underpin this standard such as load control and vehicle maintenance can contribute toward reduced fuel consumption and hence reduce atmospheric emissions.

Durban's integrated development plan (IDP) further proposes the development of a logistics platform to co-ordinate and facilitate freight movements to make more efficient use of freight transport options (EM, 2009). This logistics platform in conjunction with the road transport management standard can assist in encouraging more fleet operators to adopt measures to improve efficiency. However, a more legislative-based approach can also be taken. Specifically, emissions standards for on-road heavy-duty vehicles could be implemented, thus forcing the transformation of vehicles in this sector. The proposed emissions standards for medium and heavy-duty vehicles in the United States of America, which incorporate the weight of payloads is a good example of this (US-EPA, 2010).

2.2.2 Air quality and climate change feedbacks

Climate change and air quality issues are further intrinsically linked through complex atmospheric feedbacks that need to be considered within an AQMP. Specifically, SO_2, NO_x and PM impact on the earth's radiative forcing through short-term cooling and warming effects. Air pollutants further act to influence the lifetime and concentration of pollutants in the atmosphere. For example, an air pollution intervention measure may decrease NO_x

emissions, but may have other impacts on pollutants that influence the climate, which in turn could have complex feedbacks as shown in Figure 3 below.

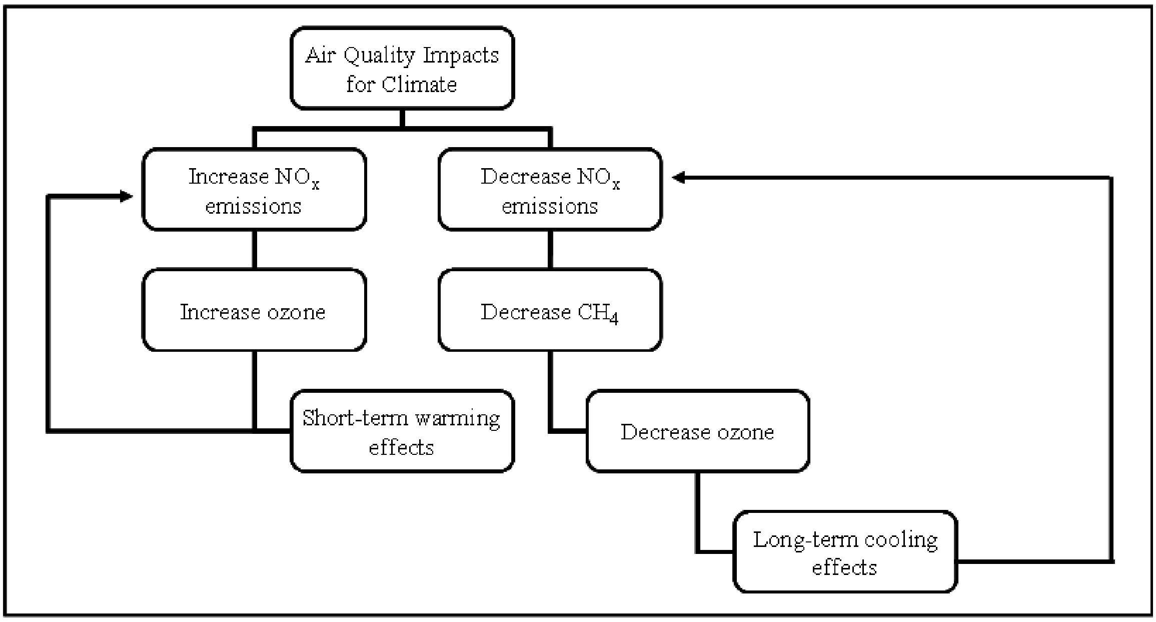

Figure 3: Air quality and climate change feedbacks associated with changing NO_x emissions

The reduction of NO_x would thus seem to offer favourable results for both air pollution and climate change. For other pollutants such as SO_2 the decision becomes more complicated, which could promote the increase of air pollutants in support of climate cooling. Thus policies that focus on this possible benefit for climate may result in 'perverse incentives to increase emissions and degrade air quality' (Rypdal *et al*., 2009, 867). These feedbacks highlight the synergies and uncertainties that are inherent in trying to establish the best AQM intervention to implement. Thus, when selecting an intervention to meet air quality targets, there need to be criteria in place to ensure that the impacts on climate change are also considered. Metrics such as global warming potentials (GWPs) could be used to gauge the impact for climate, which could then be weighed against the potential impacts on ambient air quality.

The focus of local action toward reducing NO_x and PM emissions to meet emission standards under the AQA could thus act to support long-term climate cooling effects. In the case of SO_2, especially where mean annual ambient air quality targets are now being met, the impact of further SO_2 reductions for decreasing short-term cooling effects needs to be considered and the trade-offs clearly communicated to encourage action toward reducing climate change pollutants with warming effects.

2.2.3 Climate change impacts on air quality

In AQM, emission standards are based on scenarios that will allow for progressive decreases in primary anthropogenic pollutants such as NO_x and PM through the application of air pollution prevention or control measures. It is expected that such emission reductions will contribute to improved ambient air quality to levels that do not compromise human health. However, such predictions of emission reductions are thought to be misleading, as these estimates are typically made on the assumption that the climate will remain constant. It is suggested that future climate change is likely to impact the meteorological factors that influence air quality (Hedegaard *et al*., 2008), with the potential to increase the severity and duration of air pollution events.

For Durban, projections of climate change show that an increase in the number of hot days can be expected, with the occurrence of consecutive days with temperatures above 30 °C in the summer months of January and February being 5 to 6 times higher, and 12-14 times in March, October and November (Naidoo *et al*., 2006). Changes to temperature have important implications for natural and anthropogenic emissions of primary pollutants and secondary chemical reaction rates. Furthermore, Engelbrecht (2005) indicates that under future climate change scenarios there will be an intensification of the Hadley circulation cell, with important implications for South Africa. This is significant, as intensified high pressure systems are characterised by stable conditions and temperature inversions, reducing air pollution dispersion and increasing the potential for pollutants to stagnate in an area.

Despite the knowledge of the possible impacts of climate change on meteorological factors that are likely to influence air pollution, this has not been taken into consideration in the development of Durban's AQMP. AQM systems in the city do not currently include any linkage to projected future regional meteorology preventing an understanding of whether projected climate change will act to exacerbate air pollution in the area. The AQM systems needs to be expanded to include a longer term vision, where global circulation and regional meteorological models are used to obtain an indication of future large scale and synoptic weather patterns which should then be combined with air quality models. Access to such information would ultimately allow for the AQMP to effectively support local adaptation plans and raise awareness on the possible impacts of climate change on air quality.

2.3 Summary of case study

The case study illustrates the opportunities and complexities involved in trying to incorporate climate change concerns into an AQMP. In the short-to medium-term the challenge is to ensure that air quality interventions that do not act to negatively influence GHG emissions are prioritised. In Durban, industrial fossil fuel consumption and road transportation present cross-cutting policy imperatives and the decisions taken to meet these specific challenges may determine the city's success in simultaneously achieving air quality targets and mitigating climate change. Significant co-benefits can therefore result from improved co-ordination of industrial, energy and transport plans. However, existing air quality related legislation has a limited role to play in ensuring that air quality interventions are prioritised to have co-benefits or at least result in minimal increases in GHG emissions. In the long-term, climate change impacts on meteorological factors that influence air quality also need to be considered in the AQMP so that the most effective interventions can be selected to support the city's climate change adaptation and mitigation goals.

3. Key recommendations for the inclusion of climate change consideration into local AQMPs

3.1 Short-to medium-term climate change concerns in AQMPs

The South Africa government has proposed taking voluntary action, contingent on amongst others the provision of financial and technological support, to reduce its carbon footprint by 34% in the next 10 years (DEA, 2010) with the legislation to support these GHG reductions still being developed. South African air quality legislation further highlights the importance of ensuring that AQM practices take cognisance of GHG emissions. However, presently there is no policy direction as to how this can be achieved, with the result that the actions and decision-making processes related to AQM at all spheres of government ignore the potential climate change implications. In the absence of national legislative support, a co-benefits approach to AQM could help to co-ordinate and prioritise different strategies within a city and ensure that the best policies for simultaneously meeting the multiple goals of road safety, use of cleaner fuels, and air pollution reduction are implemented. Furthermore, such an approach may help to bridge the gap between the implementation of climate change and air quality policies, allowing for progress to be made in terms of GHG mitigation in the short-term.

A comprehensive emissions inventory of air pollution and GHG emissions, developed by cities using a nationally consistent approach will provide a platform to guide equitable GHG emission reductions and allow for the identification of opportunities to achieve co-benefits. Scientific knowledge on synergies and trade-offs needs to be translated into policies that will support the adoption of co-beneficial measures. AQMPs need to be designed to take cognisance of impacts for GHG emissions, avoiding increases in GHG emissions.

To achieve this, the major polluting sectors and local authorities tasked with control over them, need to be educated about interventions that have co-benefits. With this approach it is hoped that the realisation of the potential multiple environmental benefits will encourage the voluntary adoption of co-beneficial emission reduction measures, even though it is recognised that there are no financial incentives or disincentives associated with achievement or non-achievement of emission reductions respectively. Such an approach may lack the same support as one based on regulations with resultant financial or other penalties (Rehan and Nedhi, 2005), but it is considered to be a short-term option.

Existing air quality related legislation has a limited role to play in ensuring that interventions with co-benefits are prioritised. In the case of the industrial sector, AELs or municipal by-laws can ultimately be used as the mechanisms to regulate the extent to which industries are required to consider the climate change implications of their air quality interventions.

Opportunities for co-benefits are potentially much larger within the road transport sector. However, the options that a city has to achieve these co-benefits are far more limited, as there is currently no national legislation or policy that regulates VKT. Furthermore, a city acting in isolation can only have a relatively minor influence over atmospheric emissions from road transport. The impacts of inter-city travelling, VKT by local motor vehicles and road freight transport may prevent significant improvements from being made from local fleet renewal campaigns. Furthermore, the average age of motor vehicles in the country is over 10 years old, thus there may be limited environmental benefits to interventions that require changes to fuel specifications and the types of fuels that are used by motor vehicles. In addition, whilst measures such as congestion charging have been shown to be successful in reducing VKT in developed cities, the implementation in South Africa may not be justifiable, and would have to be considered in the light of other socio-economic issues. Regulation of emissions from heavy-duty vehicles used to transport freight through emission standards should therefore be explored.

3.2 Long-term climate change concerns in AQMPs

Work by authors such as Nemet *et al*. (2010) suggest whilst a co-benefits approach to achieving GHG emission reductions may help developing countries overcome international collective action problems, it may also act to complicate the implementation of an international climate agreement. Specifically, the concern is that if cities within developing countries achieve GHG emission reductions as part of their air quality policies, it might prevent these countries from actively engaging with GHG emission reductions at an international level, preventing substantial GHG emission reductions from being made. Thus the question becomes, will placing climate change on the same decision-making platform as the air quality agenda detract from specific air quality and climate change goals?

There is no simple answer to this question. Within a South African context, there are potentially numerous advantages to incorporating climate change concerns into AQMPs. Adopting a co-benefits approach to AQMPs may allow for early action on climate change mitigation. It may help South African cities to recognise the value of designing their response to air quality issues in a manner that favours GHG emission reductions. This is especially relevant for cities that lack the financial resources and institutional capacity to effectively implement air quality policies as it may allow for higher levels of pollution abatement through opportunities to participate in the carbon market.

However, in the long-term, a co-benefits approach to AQMPs alone cannot be expected to meet GHG mitigation targets. Policies that require cities to develop GHG emissions action plans should also be promoted. These climate policies should further support interventions with co-benefits for air quality. Thus, in the long-term, a system that integrates projections of the city's future economic growth with the local government's AQMP and climate change mitigation goals would highlight the responses needed from industries, and transport and energy departments (Fig. 4). The interventions need to be considered within the context of local adaptation to climate change, to ensure that ambient air quality standards will be achieved within a changing climate. As interventions may offer disputed benefits for climate change and air quality due to the complex linkages, interactions and feedbacks that exist (described earlier), the long-term vision for air quality and climate change mitigation in the city together with a risk assessment framework should ultimately guide the selection of an appropriate measure.

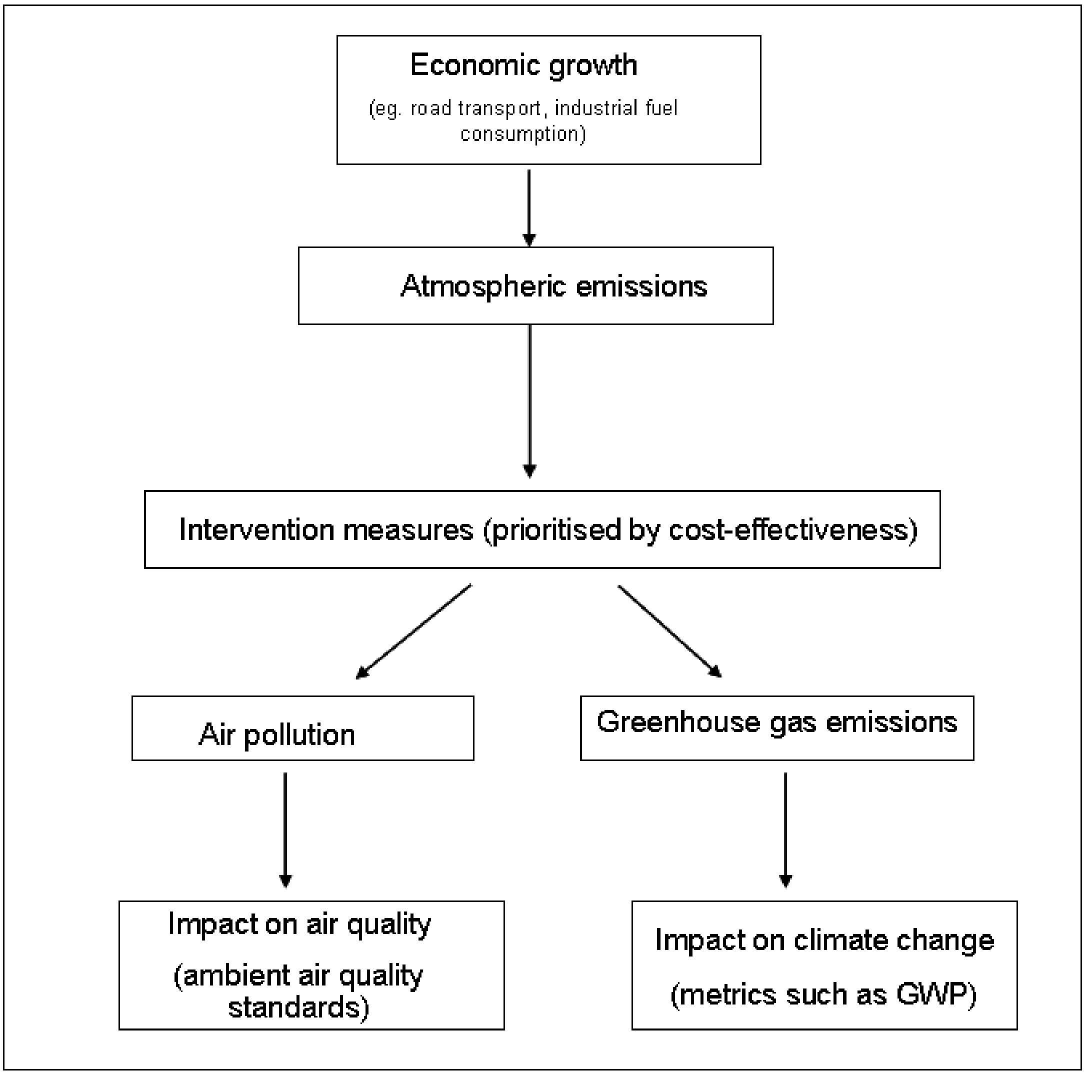

Figure 4: Long-term approach to air quality management and GHG mitigation

4. Concluding remarks

Local AQMPs present an opportunity for authorities to ensure that air quality policies are used to promote a culture of awareness of the need to reduce GHG emissions and to place climate change issues on the table for decision-makers. Despite the lack of climate change mitigation targets for cities, local AQMPs could still be used to influence the adoption of best practices to at least curb the growth of GHG emissions. Cities that envision themselves as becoming low carbon societies thus need to consider and plan for the role that AQMPs can play in achieving this goal. The challenge that faces policy-makers is to convert the potential for climate change co-benefits from AQMPs into operational policies that best exploit the synergies in light of sustainable development goals, availability of resources, and overcoming any political, technological and financial barriers that exist.

The implementation of policy, education and increased awareness of the opportunities for co-benefits are important steps that have to be taken. Specifically, in the short- to medium-term, climate change mitigation considerations need to be integrated into existing air quality policies and legislation in order to facilitate effective co-management of the issues. Policies or strategies that regulate the implementation of AQM interventions in favour of those with co-benefits for GHG emissions need to be developed. The legislative controls should ideally filter down from the AQA to provincial and local authorities, so that a consistent approach is applied to all related activities and sources of emissions. In this way no particular city or sector is unfairly regulated and the competitiveness between cities is not influenced. However, cities should be allowed to be proactive and develop stricter guidelines and take action to promote a co-benefits approach through municipal by-laws.

In the long-term, a co-benefits approach to AQM cannot be expected to adequately address the linkages between air quality and climate change, as it does not take into account complex atmospheric feedbacks and climate change impacts on air quality. Local AQMPs thus needed to be designed to take cognisance of the long-term adaptation and GHG mitigation objectives of the city. Success in implementing an integrative approach to AQM at a local level could make it more feasible for higher levels of government to adopt similar policies.

References:

(APINA) Air Pollution Information Network for Africa. (2010). APINA Objective 2. Technical capacity in air pollution assessment developed and/or enhanced. Available at: http://www.sei-international.org/rapidc/apina-objective2.htm Date accessed: 1 November 2010.

Burch, S. (2009). In pursuit of resilient, low carbon communities: An examination of barriers to action in three Canadian cities. *Energy Policy*, doi: 10.1016/j.enpol.2009.06.070

Cokayne, R. (2009). Limiting trucks not good for economy. RFA slates cuts in axle limits. Business Report, 10 December 2009, pg 4.

(DME) Department of Minerals and Energy. (2003). White Paper on the Renewable Energy Policy of the Republic of South Africa. Department of Minerals and Energy, South Africa. Pretoria

(DEA) Department of Environmental Affairs. (2010). General Notice: National Climate Change Response Green Paper 2010. Available at: www.environment.gov.za/Documents/.../climate_change_greenpaper.pdf Date accessed: 24 November 2010.

(EEA) European Environmental Agency. (2008). Success stories within the road transport sector on reducing greenhouse gas emission and producing ancillary benefits. Technical report No 2/2008. ISSN: 1725-2237. Available at: http://reports.eea.europa.eu/technical_report_2008_2/en/#documentContent Date accessed: 12 August, 2008.

(EM) eThekwini Municipality. (2003). eThekwini Municipality greenhouse gas emission survey 2002. eThekwini Municipality Environment Branch. 56pp.

(EM) eThekwini Municipality. (2005). Annual report 2005: eThekwini air quality monitoring network. 45pp

(EM) eThekwini Municipality. (2008). Annual report 2008: eThekwini air quality monitoring network. 46pp

(EM) eThekwini Municipality. (2007a). Air quality management plan for eThekwini Municipality, KwaZulu-Natal, South Africa.79pp.

(EM) eThekwini Municipality. (2007b). GHG data collection and emissions inventory report. 2005/2006 eThekwini Municipality Financial Year. eThekwini Municipality Environmental Management Department. 36pp. Available at: www.durbanportal.net/.../eThekwini%20Policy%20and%20Guidelines/Durban%20GHG%20Inventory%202006.pdf Date accessed: 21 September 2009.

(EM) eThekwini Municipality. (2009). Integrated development plan. 5 year plan 2006/07 to 2010/11, 2009/2010 Annual Review. 158pp.

(EM) eThekwini Municipality. (2010). Annual report 2009/2010: Chapter 1 – Introduction and municipal overview. Available at: www.durban.gov.za/durban/government/ar/0809/ar-chapters/Chapt1.PDF Date accessed: 5 November 2010.

Engelbrecht, F. (2005). Simulations of climate and climate change over southern and tropical Africa with the Conformal-Cubic Atmospheric Model, in R. E. Schulze (ed.), Climate Change and Water Resources in Southern Africa: Studies on Scenarios, Impacts, Vulnerabilities and Adaptation, Water Research Commission, WRC Report 1430/1/05, 57-74.

Fenger, J. (2008). Air pollution in the last 50 years – from local to global. *Atmospheric Environment*, 1-10.

Granberg, M. and Elander, I. (2007). Local governance and climate change: Reflections of the Swedish Experience. *Local Environment*, 12 (5), 537-548.
Greene, D.L., Patterson, P.D., Singh, M. and Li, J. (2005). Feebates, rebates and gas-guzzler taxes: a study of incentives for increased fuel economy. *Energy Policy*, 33, 757-775.

Hedegaard, G. B., Brandt, J., Christensen, J.H., Frohn, L. M., Geels, C., Hansen, K. M. and Stendel, M. (2008). Impacts of climate change on air pollution levels in the Northern Hemisphere with special focus on Europe and the Arctic. *Atmospheric Chemistry and Physics*, 8 (12), 3337-3367

Kennedy, C., Ramaswami, A., Carney, S., and Dhakal, S. (2009). Greenhouse gas emission baselines for global cities and metropolitan regions. Proceedings of the 5th Urban Research Symposium, Marseille, France, 28-30 June, 2009.

Naidoo, S., Hounsome, R. and Iyer, K. (2006). Climatic future for Durban. Report prepared for the eThekwini Municipality. 204pp

Nemet, G.F., Holloway, T. and Meier, P. (2010). Implications of incorporating air-quality co-benefits into climate change policymaking. *Environmental Research Letters*, doi: 10.1088/1748-9326/5/1/014007.

Poudenx, P. (2008). The effect of transportation policies on energy consumption and greenhouse gas emission from urban passenger transportation. *Transportation Research* Part A, 42, 901-909.

Rehan, R. and Nehdi, M. (2005). Carbon dioxide emissions and climate change: policy implications for the cement industry. *Environmental Science and Policy*, 8, 105-114.

Rypdal, K., Rive, N., Berntsen, T., Fagerli, H., Klimont, Z., Mideksa, T.K. and Fuglestvedt, J.S. (2009). Climate and air quality-driven scenarios of ozone and aerosol precursor abatement. *Environmental Science and Policy*, 12, 855-869.

(SA) South Africa. (2009). National Environmental Management: Air Quality Act, 2004 (Act No 39. of 2004): National ambient air quality standard. Government Gazette, 534: 32816. 24 December 2010

Thambiran, T. and Diab, R. (2010a). A review of scientific linkages and interactions between climate change and air quality with implications for air quality management in South Africa. *South African Journal of Science*. doi:10.4102/sajs.v106i3/4.56

Thambiran, T. and Diab, R. (2010b) Air quality and climate change co-benefits for the industrial sector in Durban, South Africa. Unpublished Phd Research.

Thambiran, T and Diab, R. (2010c). Air quality and climate change co-benefits in Durban. Proceedings of the annual NACA conference, 13-15 October, 2010, Polokwane, South Africa.

Thambiran, T. and Diab, R. (2011) Air pollution and climate change co-benefit opportunities in the road transportation sector in Durban, South Africa. *Atmospheric Environment*. doi: 10.1016/j.atmosenv.2011.02.059

(US-EPA) United States Environmental Protection Agency. (2010). EPA and NHTSA propose first-ever program to reduce greenhouse gas emissions and improve fuel efficiency of medium and heavy duty vehicles: Regulatory announcement. October 2010. Available at: http://www.epa.gov/otaq/climate/regulations/420f10901.htm Date accessed: 4 November 2010.