Saltsjöbaden 6, Göteborg, Sweden, 19-21 March 2018

Clean Air in Cities – Working Group report

Working Group coordinators:
Laurence Rouil
Roald Wolters

Introduction

Despite improvements over the last decade, air pollution remains to be one of the major environmental causes of premature deaths. Exposure to air pollutants such as Particulate Matter (PM), nitrogen dioxide (NO_2) and ozone (O_3) is an ongoing threat to public health. The WHO estimated that worldwide more than four million people die prematurely every year due to exposure to ambient air pollution[1]. According to the OECD this number will increase to 6-9 million in 2060 if countries will not take measures to improve air quality[2].

The negative impacts of air pollution are most distinctly felt in urban areas. Economic activities are to a large extent concentrated in or close to cities. Around 55% of the world's population lives in urban areas and for Europe this number is almost 75%. It is estimated that more than 80% of the population of European cities is exposed to annual $PM_{2.5}$ concentrations that exceed the WHO air quality guideline[3].

How to approach urban air pollution

The most significant air pollutants in cities today are $PM_{2.5}$ and NO_2. NO_2 originates mainly from transport. $PM_{2.5}$ originates to a large extent from the combustion of coal or wood for residential heating and from the formation of secondary particulates (mostly ammonia (NH_3) related) that can involve non local sources through long range transport. When the share of (older) diesel vehicles is high, transport might also contribute significantly to $PM_{2.5}$. It is impossible to identify one pollutant as the most important one, as concentrations vary substantially between cities and regions, depending (amongst others) on the presence of different sources and the time of the year (e.g. ammonium nitrate episodes in spring).

To identify cost-effective measures that can be taken by cities, it is important to not only look at the health effects of the individual pollutants, but also to the type of sources and geographical origin of the pollutants. $PM_{2.5}$ is causing more premature deaths than NO_2. Local contribution to $PM_{2.5}$ concentrations in cities ranges in Europe from less than 20% to more than 50%. NO_2 concentrations are in general caused by local emissions and thus easier to control by local authorities.

---

[1] Global Burden of Disease Study 2015. Lancet. 2016; 388: 1659–1724
[2] OECD (2016) - The Economic Consequences of Outdoor Air Pollution.
[3] EEA (2017) - Air quality in Europe 2017.

Development of local air quality policies should preferably start from locally known sources of air pollution, which also offer possibilities to identify measures that can be addressed locally. Such a source-based approach will also give a quick insight in the options that profit from co-benefits with other policy areas, such as climate/energy, noise, health and traffic/urban planning. Two key measures are reducing local coal and biomass burning to improve air quality and reduce greenhouse gases, and reducing congestion to improve mobility, improve air quality and reduce noise.

Another important aspect to take into consideration when developing a policy to improve air quality is to what extent people are actually exposed to air pollution. As people in general don't work at the same place as where they live, policies based only on residential information might not lead to the desired health improvement. Exposure-based policies will however need good coordination between air quality and urban planning policies.

Although in general an important amount of air pollution in cities originates from regional, national or even international sources, it is crucial to realize that activities in cities also create air pollution that will influence regional and national air quality. Thus, local air pollution policies should not only focus on exposure in hot spot areas in the cities, but also contribute to reducing background air pollution levels.

Exsisting tools for city support on their air quality situation:

- The Joint Research Centre (JRC) published in 2017 the '*Urban $PM_{2.5}$ atlas, Air quality in European cities*'. In this Atlas, both spatial contributions and sectorial contributions to $PM_{2.5}$ concentrations are quantified for 150 European urban areas, based on the SHERPA tool. (https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/urban-pm25-atlas-air-quality-european-cities) (EU-scale).
- A number of countries and cities developed their own air quality assessment tools based on monitoring networks and models. Guidelines to develop and evaluate such models are discussed in the FAIRMODE initiative (http://fairmode.jrc.ec.europa.eu/) led by the JRC to support use of modelling in the implementation of the EU directives

How to improve air quality at local level

A series of measures to improve air quality in cities already exist, but there is not one solution that fits all. What can be done in a city depends as said on the sources, but also resources of the city. Possibilities also depend on whether there is willingness at the political level to not only reduce emission via technological improvements but also by decreasing activity rates or implementing structural and societal changes. In order to be successful, it is crucial that there is public awareness about the need to take measures as well as acceptance of the measures by society. Assessment of actual health effects also requires consideration of actual exposure, using exposure indicators next to assessment of air quality limit values.

Even though there are differences between cities, it is possible to list best practices. It is then up to the authorities to assess the actual situation to choose for the measures that fits best to the local situation. For NO_2, the most implemented measures are:

1. Reduce traffic, promote walking and cycling (implementing new mobility plans including modal shifts).
2. A shift to electric vehicles, busses and LDVs/HDVs.
3. Introduction of low emission zones (where efficiency depends highly on size of the zone as well as the type of vehicles that are banned), congestion charges.
4. Reduced speed limits.
5. Changed traffic circulation.

For $PM_{2.5}$, the measures implemented most at local (city) level are:

1. A reduction or ban on the use of fossil fuels or biomass for household heating.
2. District heating, clean alternatives, energy efficiency.
3. A reduction of the use old diesel vehicles in cities.

Exsisting tools for city support on measures:

- The JRC hosts the *'Catalogue Of Air Quality Measures'*, which provides a selected number of successful (best practice) and unsuccessful Air Quality measures. (http://fairmode.jrc.ec.europa.eu/measure-catalogue/) (global use)

There are many proven measures to tackle air pollution, but the question is where they will be most efficient, at city level and if so in which city, or at a regional level, but then again which region? It is clear though that, in order to solve air quality problems, regional and transboundary policy coordination remains necessary. Local actions are an effective means of improving air quality but these need to be supported by regional and national (sectoral) emission reductions. A large part of $PM_{2.5}$ concentrations in cities is secondary PM formed by reaction of NH_3 with other pollutants, such as NO_x and SO_x. To tackle this, reduction of NH_3 emissions is required, especially in areas where other pollutants are in excess in the atmosphere. Progress can also be achieved by reduction of emissions from other sources in the region and nationwide. Understanding chemical regimes that drive the chemical processes in the atmosphere and a good knowledge of emissions are essential to promote the best control decisions.

Gaps in technologies, products and services

Much information is already available, enabling cities to improve local air quality. In order to be able to achieve concentrations close to or even below the WHO guidelines, more knowledge is necessary. National governments as well as the EU and the UNECE Air Convention have here a clear role to play, as it is impossible to do the necessary research at city level, but also to ensure a harmonised approach.

Emission inventories and source apportionment

There are currently many assumptions and uncertainties in the emission inventories. Knowledge on real world emissions is lacking for some sources, such as wood stoves and road traffic, for which emission factors have been underestimated in the past. Theoretic values in general differ from real world emissions so there is at least a correction factor needed. The latter should be scientifically justified and approved by international and national authorities to reduce uncertainties and develop comparable approaches.

Activity data also needs to be improved, for instance for domestic wood burning. Using 'wood sold' will generally result in an underestimation as a lot of wood used for household purposes comes from other sources than official sellers.

More information is also needed on how to assess the impact of local emission reductions at the regional scale, for instance in the production of secondary aerosols (NO_x contribution).

Health issues
Although limit values are appropriate – and necessary – as a basis for control, a thorough assessment on the health impacts requires a broader approach. Research shows that some components of $PM_{2.5}$ might be more toxic than others. Black carbon is most likely part of the more toxic $PM_{2.5}$, as are particles that contain substances such as BaP, which is linked to combustion processes. Further complicating is the fact that there is also overlap in health effects between $PM_{2.5}$ and NO_2. It is not clear to what extent health effects are different when people are exposed to a combination or cocktail of different pollutants. In real life, exposure to such a cocktail is the most likely situation. Scientific agreement is also missing on the health effects of ultra-fine particles. Important to note is that there is no doubt that $PM_{2.5}$ has significant negative impacts on health and should be kept as a representative tracer of such effects.

Against this background, additional research on health impact as well a review of scientific knowledge is recommended on the quantification of the effects. To support the development of effective and state of the art policies on air quality, a quick update of the WHO air quality guidelines is necessary. The current version stems from 2005 and there is sufficient evidence that a tightening of the values would be justified.

Green infrastructure
It is known that trees can help extracting air pollution from the air, but trees can also create street canyons which will lead to an accumulation of pollutants below the canopy. It would be recommendable to invest in a thorough study of the actual effects of green in cities and how it can be used in the most efficient way.

Communication
In order to ensure effective implementation of air quality policies , proper information the public is a must. A first step would be to inform, regional and national authorities, as there appears to be a big difference in actual knowledge from the government side. It is important to find communication strategies that will reach as many stakeholders as possible. In order to guarantee reliable and harmonized information, there is an important role for international organisations such as the EU, UNECE, WHO and UNEP.

Special attention is needed for sensitive groups such as elderly and children if we want to involve citizens. Citizen science should be promoted and used to raise awareness.
The use of low cost sensors for air quality plays a particular role in this. It is important to stress though that the quality of the data from those low cost sensors is in general far from sufficient to be used for drawing conclusion on the actual air quality situation and form basis for control measures.

Communication to authorities should also include information on potential measures and methodologies to develop air quality plans, including information on benefits, trade-offs, cost-effectiveness and potential co-benefits with other policies. This links to the need for harmonization of practices for local measures, such as retrofit approaches and low emission zones. It is recommended to the parties to review and share their success story in the cities.

Governance
Tackling air pollution is a complex challenge that requires concerted action across societal actors and economic sectors. To find the best solutions it is necessary to bring together economic sectors like transport, energy, agriculture and industry, all levels of governance at the global, European, national, regional, and city level, and policy areas such as environment, climate and energy, mobility, agriculture, and fiscal policy, while always keeping citizens at the heart of these issues. It is not only a problem of scale but also of balance between sectors and other policies.

Regarding potential action in cities it is necessary to assess what exactly is under control of the cities and to keep in mind that it can change from a country to another and from a city to another. Therefore local actions need to be city specific. Given the limited capacity of cities, especially the smallest ones that lack the capacity to develop complex studies, support on how to develop cost-benefits analyses would enable cities to do more. Supporting local policies with national and international ones is essential. It is crucial not only to focus on measures in affluent countries but also measures that can be implemented in low(er) incomes countries.

The role of the UNECE Air-Convention
Even if the Convention has as its main objective to consider transboundary air pollution, it has become increasingly evident that its strategies need to take into account the air quality in urban areas. One of the Conventions' strengths is the vast and committed scientific community supporting policy-making. This should remain to be at the core of the Convention and should also be the core when it comes to a focus on cities. As discussed above, air quality in cities is very much dependent on air pollution originating from regional and (inter)national sources, but cities also contribute highly to air pollution outside the cities. In this light, the scientific bodies under the Convention could focus also on the city scale and assess the contribution of long range transport to air pollution in cities.

This should however not be understood as a recommendation to provide support from the Convention to cities on an individual basis, but to provide cities with the tools that will enable them to take well-informed and justified decision on the most cost-beneficial approach to tackle air pollution. The scientific community can generate knowledge and methodologies to be used by local authorities, but also regional and national authorities to support their cities. Linkages between both scales should be considered in the tools developed and promoted by the scientific community. Next to this the Convention should also raise awareness (together with cities and countries), share knowledge and methodologies and ensure harmonization.

Conclusions

Measures and inventories

There is a need to further assess the impact of local emission reduction strategies at the regional scale (e.g. production of secondary aerosols, ozone) and the impact of long range air pollution at the city scale. Scientific questions that need further consideration include aerosols formation, uncertainties in emission data and health impacts. There is a need to assess cost-efficiency of trade-offs and co-benefits of combined strategies and interactions between different pollutants and sources.

Health

There is a need to have updated WHO Air quality guidelines as soon as possible to support health analyses and help in cost-benefits analyses (including priorities on the most sensitive pollutants). The update of the current WHO Guidelines won't be ready before 2020, so it would be good if the WHO could come up with intermediate results that focus at least on the European region. It would be possible for the European Commission to ask for a fast update of the HRAPIE conclusions.

Communication

There is a need for support with information on possible measures and the effects of those measures for the local level. For this it would be recommended to assess potential partnerships with existing city initiatives, such as the EU's Urban Partnership on Air Quality and the Global Urban Air Pollution Observatory (GUAPO). It would also be worthwhile to assess to what extent it is possible to make a link with the Covenant of Mayors. The Covenant of Mayors currently only focuses on local actions on climate and energy.

Recommendations for clean air in cities:

1. There is a need to further assess the impact of local emission reduction strategies at the regional scale (e.g. production of secondary aerosols, ozone), and the impact of long range transport at the city scale: improve science and communication (*UNECE Air Convention's scientific bodies and WGSR*).
    - Local authorities need to be better informed about the stakes and the actual impacts of local air pollution control strategies.
    - Scientific questions are still open: aerosols formation, uncertainties in emission data, health impacts, etc.
2. Supporting local policies with national and international ones is essential (EURO standards, wood stoves regulation, etc.) to increase their efficiency (*UNECE Air Convention's scientific bodies (TFMM, TFIAM) for the demonstration and to WGSR for communication*).
3. If thorough embedding of urban air quality is preferred, there is a need for the Convention to account for the city scale in its mandates. This should be considered in the revision of the long term strategy of the Convention and its bodies' work plans (*Executive Body*).
4. A relatively low profile solution to embed the local level is to add an expert panel (under TFIAM or WGSR?) to work on the subject: define the needs, promote the results (*Executive Body*)
5. There is a need for "user-friendly" guidance documents for local level air quality assessments and abatement options. For example, review and classification (even

qualitative) of measures regarding their impact (high or low) and costs independent of scale (*WGSR, EMEP SB, and WGE*).

- This could be done through extension of existing documents to include city scale issues (e.g. emissions inventories).

6. There is a need to have updated AQ guidelines as soon as possible to support health impact and cost-benefits analyses (including priorities on the most sensitive pollutants): request for intermediate results for Europe (*European Commission, WHO*).
7. There is a need to assess cost-efficiency of trade-offs and co-benefits of combined strategies (air pollution and climate, energy, mobility, health, etc.) and interactions between different pollutants and sources (*TFIAM and CIAM*).
    - Communication should target "air pollutants" rather than individual substances and use health indicators.
    - Focusing on sources in the air pollution control strategies may be more important than targeting pollutant.