Chapter 6
Integrated Assessment

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Introduction

There are important interactions and potentially large economic synergies between air quality strategies and the objectives of EU social and economic policies, including the EU policies on energy, agriculture, transport and climate change. These complex - and well documented - interactions impose formidable challenges to decision makers. Unless incorporated into the process, these interactions could prohibit cost-effective solutions and also unnecessarily waste important resources of Europe's economy.

Integrated assessment, based on latest scientific findings and validated data, can provide valuable information on the design of cost-effective strategies that meet multiple policy objectives. Integrated environmental assessment brings together knowledge across scientific disciplines with the purpose of providing relevant information to decision makers.

In the past, integrated assessment modelling has been extensively used as an analytical backbone of the Clean Air For Europe (CAFE) programme of the European Commission that provided the knowledge base for the Thematic Strategy on Air Pollution (TSAP).

Since then, methodologies for integrated assessment modelling have been further developed at the European level along multiple avenues. Numerous EU-FP6 and FP7 projects addressed specific aspects that are relevant for air pollution control strategies. Under the EC4MACS project of the EU-LIFE program, a toolbox of well established modelling tools that have already been used for earlier policy analyses has been developed to explore the synergies and interactions between climate change, air quality and other policy objectives.

The EC Framework Programmes and other directed research contribute to the methodological development as well as underpinning scenario and policy analysis

***Q1.* How can policies be developed to address impacts of both air pollution and climate change?**

Policies that reduce air pollution, in most cases also influence greenhouse gas emissions and policies that are designed to reduce greenhouse gas emissions in most cases also decrease or increase emissions of air pollutants. A recent paper in Nature by Shindell et al. (2012) illustrates the synergies between climate change (specifically, the near-term effects of reducing ozone and black carbon, both short-lived climate pollutants, SLCPs), human health and food and energy security. The GAINS model has been extended to consider the impacts of ~3,000 specific mitigation measures on the emissions of short- and long-lived substances, and to quantify their impacts on human health, ecosystems, and radiative forcing. With appropriate quantification, in particular of the climate impacts, the GAINS optimization provides a methodology to develop cost-effective portfolios of measures that maximize the benefits on human health, vegetation and climate change.

The FP7 Climate Cost project assessed the co-benefits of global post-2012 greenhouse gas mitigation strategies on air pollution (Rafaj et al. 2012). It was found that in 2050 expenditures on air pollution control under a global climate mitigation regime would be 250 billion € lower than in a business-as-usual scenario. Around one third of financial co-benefits estimated world-wide in this study by 2050 occur in China, while an annual cost saving of 35 billion € is estimated for the EU if the current air pollution legislation and climate policies are adopted in parallel. Health impacts of air pollution are quantified in terms of loss of life expectancy related to the exposure from anthropogenic emissions of fine particles, as well as in terms of premature mortality due to ground-level ozone.

Related activities have examined links between the nitrogen cycle and climate change (NitroEurope) and a report compiled under UNECE Task Force on Reactive Nitrogen has specifically investigated the interactions between nitrogen and climate change (http://www.nitrogenweb.info/). A case study assessing climate change policies carried out in the projects INTARESE and HEIMTSA (2011a) indicates that the effects of climate policies on reducing air pollution and human health impacts, when expressed as external costs, are of a similar magnitude as the effects these policies have on mitigating climate change. While climate policies measures often reduce human health impacts, some climate measures may increase health risks, e.g., increased biomass burning in small stoves leads to higher PM concentrations, or improved insulation of buildings with new air-tight windows increasing mould formation.

The concept of ecosystem services (ES, e.g. Compton et al. 2011), may provide an as yet missing link to quantify (and methods for the valuation of) ecosystem effects that have proven elusive in the past, often leading to a bias towards the assessment of health effects in cost-benefit analyses. Other approaches for the assessment of biodiversity losses have been developed in NEEDS and in the 'European Nitrogen Assessment' (Sutton 2011b).

The key challenges for a full integration of the assessment of climate change, human health and ecosystem damage lie in the substantial difference in spatial and temporal aspects. A modular model system with well-defined interfaces, which allow exchanging some elements (models) with other elements depending on the question addressed – a concept developed in HEIMTSA (2011b) provides a possible way forward.

Summary

> Policies to reduce air pollution in most cases also influence greenhouse gas emissions and policies that are designed to reduce greenhouse gas emissions in most cases also influence (decrease or increase) emissions of air pollutants. Furthermore some air pollutants are short lived GHGs, and climate change affects emissions of pollutants, their transport and the chemical transformation in the atmosphere. Thus an integrated assessment should assess impacts of air pollution (on human health, biodiversity, crop yield) and impacts on climate.

> To assess biodiversity losses or gains in monetary terms, some approaches (e.g. in the context of ecosystem services) have been developed that should be tested for their usefulness in future policy analyses.

> It has been suggested to employ monetized benefits as a common metric to compare impacts of air pollution and climate policies. However, such monetizations are loaded with complexities, related, e.g., to the robust quantification of the value of human life, the monetization of ecosystems impacts, and the comparison of benefits that occur at different temporal and spatial scales.

> An integrated assessment tool box should consist of modules that are linked via well-defined interfaces. The tools to be used are then chosen depending on the questions to be answered. The central provision of data needed like meteorological data, emission data, population data would help to support the assessment.

Q2. Are the scales of assessment for the different pollutants (from local scales of urban air quality to the global scale assessment of radiative forcing by GHG) properly considered in IA?

The challenges presented by conducting integrated assessment across a range of scales have been discussed by Reis et al. (2012) and previously by Oxley and ApSimon (2007). While it is tempting to aim for a 'one-size-fits-all' approach, models should only be applied for the spatial scales they have not been designed. Approaches like nesting local and national scale IAMs within more coarse European-wide models is not sufficient to make a localized analysis covering the whole of Europe, which however is necessary to assess EU policies. Thus, for the integration of local scale effects into European wide IAMs, a parameterisation of local scale effects could be used to derive an "urban increment", which is described in the following section. In addition, networking and knowledge exchange of groups developing and applying IAMs at different scales is beneficial for the methodological development of IA concepts, e.g. through the Network of Integrated Assessment Modellers (NIAM, www.niam.scarp.se).

Estimation of the urban increment: In the Megapoli project, a Eulerian model or a parameterised version of a Eulerian model is used at the European scale to estimate average annual concentrations (and deposition) of primary and secondary pollutants for each grid cell of the model domain. A grid element usually has a size of between 50km*50km and ca. 7km*7km for European wide calculations. In such a grid, there could be as well cities or city parts as non-habituated areas. From measurements it is known, that PMx background concentrations are higher in cities than outside cities. As humans are staying within the city boundaries most of the time, the concentration in the city (and not the concentration in the grid) should be used to estimate health impacts. A first attempt to generate a method to estimate the 'urban increment' was made within the 'City Delta' project (http://aqm.jrc.it/citydelta/). This attempt was considerably improved within the project MEGAPOLI (Moussiopoulos et al. 2011; Torras Ortiz 2011). Especially the use of accurate emission data for a city is an important input parameter for estimating the urban increment.

Estimation of the distribution of concentrations in cities: Measurement stations, where EU air quality limits for NO_2 and PM10 are exceeded, are often located in street canyons; furthermore people's homes are located near streets. So to analyse, whether thresholds are met and to get a better picture of the exposure of people to pollutants, not only the background concentration, but in addition the distribution of street canyon concentrations should be known. To model street canyon concentration in single streets or in a whole city, a number of models are available, e.g. those further developed and improved in TRANSPHORM. However, an application of these models for all cities in Europe in the frame of a EU wide assessment is not feasible. Instead, a statistical approach developed in MEGAPOLI could be used (Torras Ortiz 2011). However this model is only validated for German cities, thus some further work is needed, until it can be applied for all European cities.

Estimation of emission data: The scale problem also exists with regard to emission data. Annual line and area sources are first estimated per country and then distributed spatially using proxy data and spatially using temporal patterns. Recent analyses in TRANSPHORM revealed that part of discrepancies between modelled and measured PM10 concentrations might be caused by a poor temporal and spatial distribution of emission data. This could be improved by taken current improvement in the methodology for the temporal and spatial resolution into account, e.g. that emissions depend on temperature (Theloke et al. 2011; Theloke et al. 2012; Thiruchittampalam et al. 2012; Vogel et al. 2012) and on-going work e.g. in the MACC project (http://www.gmes-atmosphere.eu/) and EDGAR (http://edgar.jrc.ec.europa.eu). However, work for the EC4MACS project also highlighted clear limitations of generic downscaling processes for emission inventories, which constrain the improvements that could theoretically gained from a more spatially resolved modelling of air quality.

Summary

> Owing to the EU governance system and the transboundary transport of pollutants in Europe, air pollution policy assessments need to be conducted for the entire EU, while exposure and some measures are very local in nature. This poses challenges that have been addressed in recent FP projects. Especially for the estimation of the 'urban increment', i.e. the difference between the urban background concentration and the average concentration in the grid(s) around the city, and the estimation of the distribution of the 'street canyon increment' methods have been generated or improved.

> Methods for a better spatial and temporal resolution of emission data have been developed and should be used to improve the quality of spatially and temporally resolved emission data.

> For future air quality reviews additional insights could be gained by adding exposure modelling to the assessment.

Q3. Should the assessment of non-technical measures be included in an integrated assessment?

Cost-benefit analyses for environmental policies usually only assess costs and impacts of technical measures, i.e. measures that change the emission factor of a process, e.g. by adding a particulate filter or by increasing the effectiveness of the filter. However, as many of the technical measures are already requested by current legislation the scope for further improvements of end-of-pipe technologies is often limited.

In such cases, further substantial reductions of emissions are only possible, if non-technical measures are used; in many cases such measures require behavioural changes of people. For instance, people might refrain from using less environmentally friendly processes resp. technologies or substitute them with other better processes. This could be achieved by regulating the use of the unwanted process or by increasing the price of the unwanted process or by subsidizing the use of other more environmentally friendly processes. For example, if the tax on gasoline and diesel is increased, some users of private cars might shift to riding a bicycle or using public transport. In the projects MEGAPOLI and INTARESE it was shown, that an effective and efficient non-technical measure for reducing air pollution as well as climate change is a change of diet, especially a reduction of the consumption of meat. However, as pointed out in EC4MACS, these impacts would be limited unless milk production would be reduced simultaneously, as the current agricultural production system in Europe is closely coupled.

The costs of such measures should include the utility losses experienced by those that change their behaviour. In the example above, private car users shifting to public transport might even save money, but before the tax increase they have been willing to use their car despite the higher costs, as they feel they experience some utility gains by using their car like more comfort or better time management and no waiting times.

Thus the analysis of non-technical measures would be an important part of an integrated assessment. Examples can be found in results for the FP7 project MEGAPOLI (megapoli.info) and the German project 'PAREST' (Appelhans 2012).

Summary

> As the potential for further emission reduction from technical measures, i.e. measures that reduce emission per unit of activity, is decreasing with the stringency of emission control legislation, policy assessments should also include non-technical measures, i.e. measures that change the behaviour resp. the decisions of people. In addition, even when assessing technical measures, changes in behaviour should be considered.

> The European Commission identified the field of integrated assessment as one of the priority issues for the review and implementation of the air quality policy and has recently funded a new coordination action within FP7 (APPRAISAL). The goal is to provide scientific and technical support in this area to both the European Commission and EU Member States and regions during the on-going revision and the implementation of the EU Air policy.