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RIAT+ AND PAIR2020: AN INTEGRATED ASSESSMENT TOOL USEFUL FOR AIR QUALITY PLANNIG

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Abstract: Air quality plans are used by local authorities and national governments to identify measures to reduce the harmful effects of air pollution in compliance with the objectives for air quality. The LIFE+ OPERA project defined a methodology and it developed RIAT+ in order to support policymakers. The tool has been used to define the emission reduction targets and to identify the main intervention sectors, in order to achieve the AQD EU objectives in the framework of PAIR2020.

Key words: integrated assessment, air quality plannig;

INTRODUCTION

Air quality plans are used by local authorities and national governments to identify measures to prevent and reduce the harmful effects of air pollution on human health and environment. Due to the complexity of the phenomena involved in the formation and accumulation of secondary pollutants in atmosphere such as ozone and secondary PM, the plans must define actions to reduce precursors emissions (NH3, VOCs, SOx, NOx) as well as primary PM, by assessing the effects.

In order to achieve the respect of EU air quality thresholds, efficient measures, impacting on several pollutants two possible decision pathways can be used:

• scenario analysis: nowadays this is the approach mainly used to design the air quality plans at regional/local scale; the emissions reduction measures are selected then assessed through simulations of an air quality model; this approach does not guarantee the cost-effectiveness of the chosen measures; costs and other impacts are evaluated ex-post.

• optimization (see Figure 1): this pathway indicates the most cost-effective – technical (end-of-pipe) and non technical (energy efficiency, behavioural changes) - measures for air quality improvement by solving an optimization problem to reduce pollution and to take account of its impacts and costs.

The integrated assessment models (IAM) integrate the data on polluting sources (i.e. the emission inventory), their contribution to atmospheric concentrations and possibly the effects on human / environmental exposure; they provide informations on potential measures of emission reduction and related costs of implementation.

The LIFE+ OPERA, Operational Procedures for Emission Reduction Assessment, (www.operatool.eu) project defined a methodology and it developed RIAT+, a regional integrated assessment tool, to support policymakers to select optimal policies of air pollution reduction that will improve the air quality at minimum costs.

The tool has been used in the framework of PAIR2020 (Emilia-Romagna Regional Air Quality Action Plan) to define the emission reduction targets at regional level for the main pollutants responsible for PM and ozone pollution, and in order to identify the main intervention sectors to achieve the objectives.

WHAT IS RIAT+?

RIAT+ (Riat 2.1, userguide) is a regional integrated assessment model (IAM) that can identify the mix of actions (energy efficiency and behavioural changes) that are optimal for improving air quality. The tool uses the specific features of the area of interest with regional input data-set for the:

- emissions of precursor from local and surrounding sources
- abatement measures (technical and non-technical/energy) described for activity sector and technology with information on application rates, efficiency factor of emission removal and cost

- the effect of meteorology and prevailing chemical regimes through the use of site specific source-receptor (S/R) functions

The main outputs from RIAT+ are a summary of emission reductions on the domain, a table of the application rates for the different measures, maps of a set of relevant air quality indexes (AQIs) and, for the optimization, the Pareto Curve which provides efficient solutions of a specific AQI ranked by costs.
To limit the computational time, RIAT+ currently uses an Artificial Neural Networks (ANNs) to link emissions to an AQI.

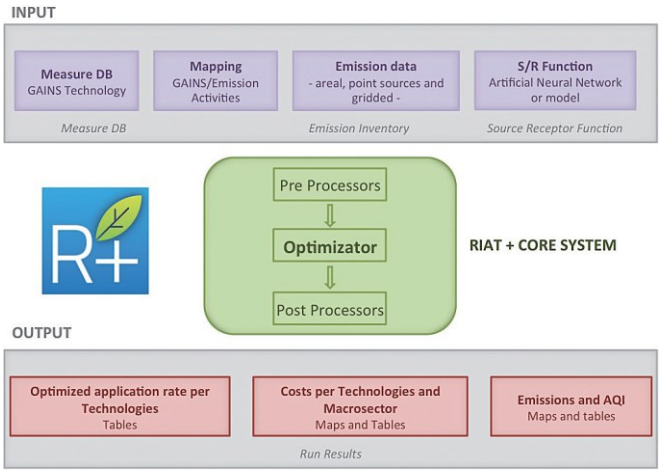

Figure 1: RIAT+ block diagram with I/O and the core system

RIAT+ AND PAIR2020 (EMILIA-ROMAGNA REGIONAL AIR QUALITY ACTION PLAN)

The Emilia-Romagna region is located in the south-western part of the Po Valley basin, a densely populated and heavily industrialized area, where the meteorological conditions, due to the low wind intensity, cause the stagnation of the air masses, associated with high pollution episodes of PM during winter and high levels of ozone during summer. The daily Limit Value (LV) for PM10 was exceeded every year since the enforcement of the EU directive (2008) with a slow decreasing trend of the PM10 annual mean from 2001.
The regional inventory of atmospheric emissions has been undertaken by regional environmental agency (ARPAE-ER) on behalf of the Emilia-Romagna Region, with reference to the year 2010 using INEMAR, a data collection and processing system developed in order to manage the development of a regional bottom-up atmospheric emission inventory for different activities (heating, road transport, agriculture, industry, etc.). Sources of PM and ozone precursors, such as NOx and VOCs, are mainly related to road transport and combustion. Almost 60–65 % PM is secondary and a large part of particulate matter and ozone pollution is due to regional background that is influenced by the transport of pollutants from the neighbouring regions of the Po Valley basin. Ammonia, mainly emitted by agriculture, is an important precursor of PM in the Po Valley. Diesel trucks are responsible for a large part of NOx emissions. Emissions from wood burning and motor vehicles (exhaust and non-exhaust) are the main sources of PM10.
The concentrations of air pollutant have been simulated for the year 2010 using NINFA, the air quality system used since 2003 in ARPAE for operational and assessment purposes. This operational modelling suite is based on the CHIMERE chemical transport model, the meteorological input is provided by the COSMO-I7 non-hydrostatic model, the domain covers northern Italy with a resolution of 5 km.
To train the ANNs, 12 emission scenarios on the Emilia-Romagna domain were designed and used.
This input allows the RIAT+ tool (Carnevale et al. 2012) to produce a spatial and seasonal disaggregation of the emissions inside the region.
In a preliminary phase of the Regional AQP, the RIAT+ has been used to assess measures and costs to improve air quality. Both technological and efficiency measure are taken into account in the optimization

process. Analysing the yearly average PM10 concentration on the whole Emilia-Romagna, a Pareto curve was obtained, the points of which represent different optimal combinations of reduction measures. The point 2 was chosen as a target emission scenario since higher emission reductions would have resulted in a significant costs increase without major benefit in term of AQI, The analysis of the Pareto curve shows that a significant reduction of NH3 should be reached acting on agriculture macro sector, while NOx reduction should be obtained through transport and other mobile sources macro-sectors. Actions on residential heating should be promoted to reduce a large part of primary component of PM10. RIAT+ gave also a detailed list of measures to obtain these reductions.

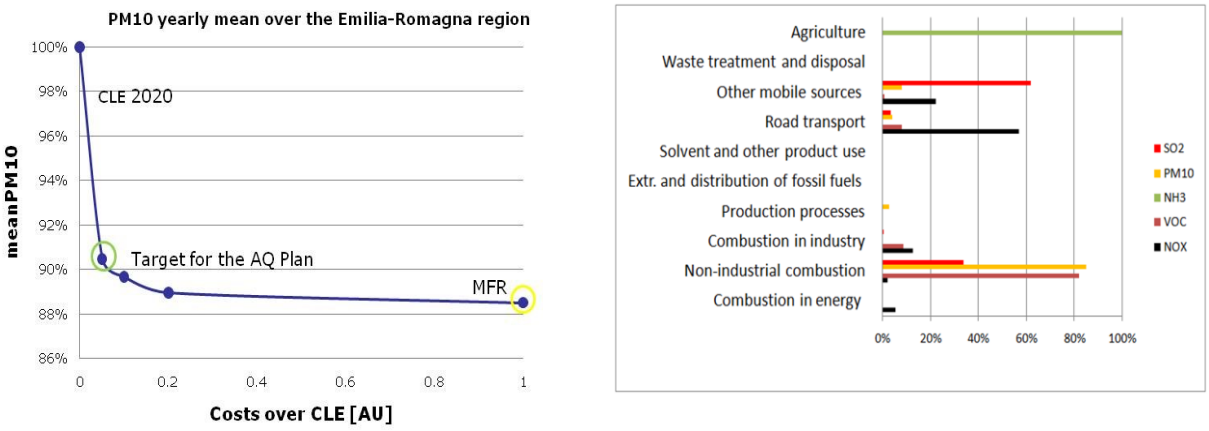

Figure 2: Pareto curve for the optimisation of yearly average concentration of PM10 (MFR is the maximum feasible reduction) and the corresponding emission reductions over CLE2020

The combination of different runs with single or multi-pollutant optimization objectives leads to the following priority list of measures to be implemented:

- Energy efficiency measures in the residential sector including improved fireplaces;
- High efficiency oil and gas industrial boilers and furnaces in manufacturing industry;
- Significant replacement of old heavy and light duty diesel vehicles with newer Euro5 and Euro6 compliant), as well as an increase of the limited traffic zones and cycling paths;
- Agricultural practices that reduce the use of urea and livestock practices more efficient for waste-water management

After several meetings with politicians, regional officials and stakeholders, the emission target scenario has been modified, without distorting its goals, reaching the definition of air quality emission plan with 94 feasible measures. In Figure 3 total annual emissions for different scenarios are shown.
The target scenario implies a reduction of 40% of NH3 emissions compared to the CLE2020 scenario, an objective deemed too difficult to achieve; on the contrary, measures to reduce emissions of PM have been tightened. Therefore the plan scenario compared to the target scenario, shows lower emissions for PM10 and higher emissions for NOx and especially NH3.
NINFA simulation for plan scenario shows that the daily limit value for PM10 is respected in a large number of stations

CONCLUSIONS

This study presents an application of RIAT+ to a ”real” case. The costs – effectiveness analysis is used to evaluate the most effective actions and to set the emission reduction target for the AQ plan. The source-receptor model is used for a fast screening of the selected set actions effects on air quality . The RIAT+ tool implemented on Emilia-Romagna provides a wide set of informations and data that support the analysis of the pollution factors responsible for the exceedances and to define the possible measures for the improvement of air quality.

The RIAT+ tool has been used to define regional air quality plan and to help regional authorities to identify non-intuitive measures (such as agricultural measures) that would be needed to improve air quality in cities. Integrated assessment tools, such as RIAT+, have therefore proved to be valuable for planning and evaluating appropriate measures of reduction of regional emissions and pollutants concentrations.

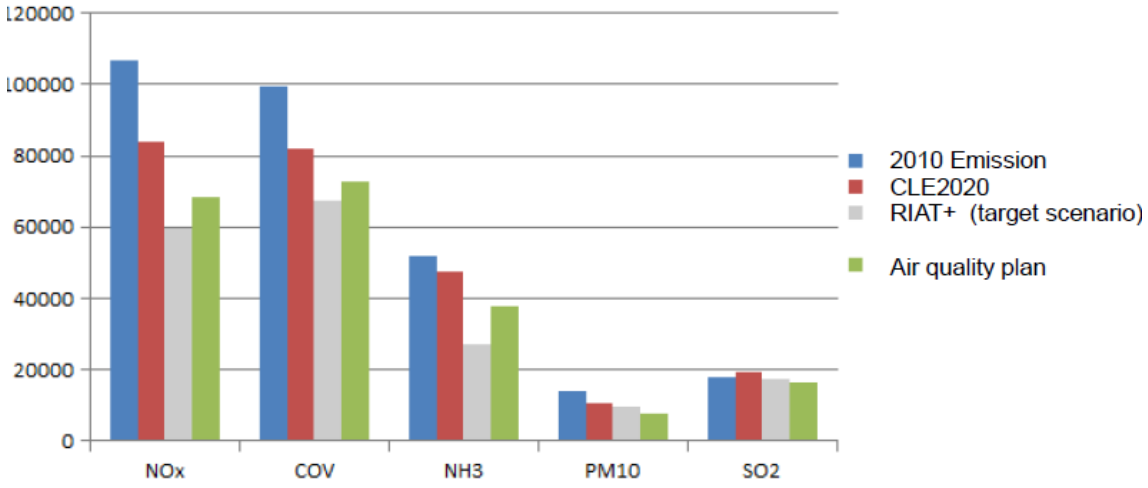

Figure 3: Emilia Romagna annual emission (tons) for each scenario

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