EMISSION REDUCTION SCENARIOS FOR THE AIR QUALITY IMPROVEMENT PLAN IN AOSTA VALLEY

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INTRODUCTION

The plan for air quality improvement in Aosta Valley sets the objectives concerning pollutant emission reductions in order to meet the regional air quality standards all over the region (ARPA VdA, 2005). These objectives have been identified through a repeated use of pollutant dispersion models (ARPA VdA, 2003, Nanni et al., 2004). Through this process it was possible to estimate emission reductions allowing to reach the limit values within the term of year 2010. The preparatory work on abatement scenarios is summarized here.

Emissions for the reference scenario in 2004 were extracted from Regional Inventory managed by ARPA for the corresponding year. Starting from the reference scenario, different future emission scenarios were then set up, some of which representing the expected trend of emission sources, others especially created to represent emissions reductions.

Five emission scenarios were considered, referring either to the whole region or only to the main town of the Valley, Aosta:

- scenario 1: vehicle fleet evolution in 2010 in the whole region;
- scenario 2: vehicle fleet evolution in 2020 in the whole region;
- scenario 3: reduction of the flow of cars and light duty vehicles in Aosta town;
- scenario 4: reduction of the flow of cars in Aosta town;
- scenario 5: reduction of industrial emissions in Aosta town.

Estimating pollutant emissions involved by each scenario and using the Lagrangian dispersion model SPRAY (Arianet, 2001), concentrations of nitrogen dioxides produced were then calculated. This pollutant is an indicator of anthropic sources pollution and it has turned out to be suitable for evaluating the main trends of interest of the air quality in Aosta Valley.

Meteorological analyses were produced starting from the data provided by the ARPA monitoring network, using MINERVE diagnostic model and SURFPRO turbulence processor (Pession et al., 2005).

Two computational grids were considered: the whole Aosta Valley region (101 x 67 km, with 1 km resolution) and the Aosta area (6 x 4 km, with 31.25 m resolution).

SCENARIOS 1 AND 2: VEHICLE FLEET EVOLUTION FOR 2010 AND 2020

The variation of the atmospheric emissions for the years 2010 (scenario 1) and 2020 (scenario 2) has been studied to estimate the environmental effects of the present trends of vehicle fleet composition (light and heavy vehicles), in terms of number of vehicles and Euro classes, leaving out specific emissions reduction measures.

To estimate the fleet evolution, the results of the European project "Methodologies for Estimating Air Pollutant Emissions from Transport" (MEET, 1999) of the Transport Research Laboratory, have been combined with the demographical data, the regional and national vehicle fleet, the age and lifecycle of the vehicles. In the calculations, the increase in the vehicle numbers foreseen by the MEET project for Italy were taken into account: cars +10% (2010) and +23% (2020), light duty vehicles +9% (2010) and +22% (2020) and heavy duty vehicles +9% (2010) and +21% (2020).

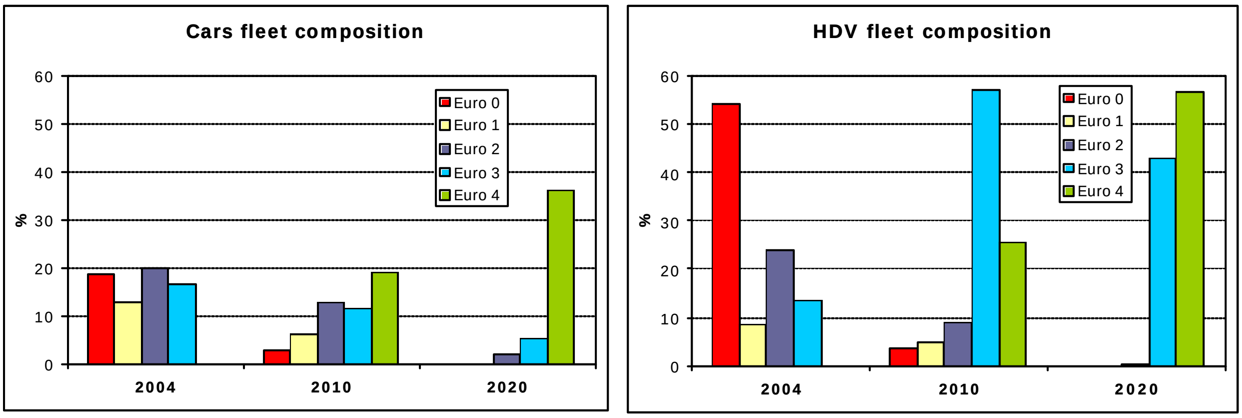

Fig. 1; cars and HDV fleet composition for 2004 and forecasts for 2010 and 2020.

Using COPERT III methodology the emissions of the main pollutants related to the road traffic have been calculated, and among them, CO_2 emissions, implied by the Kyoto protocol. These evaluations refer to 2004, 2010 and 2020.

Table 1. Road traffic emissions estimated in Aosta Valley (tons/year).

Year	CO	NOx	PM10	CO_2
2004	5513	1542	216	296513
2010	2576	1043	216	315668
2020	1625	774	219	349240

The expected emissions reduction is stronger in the period 2004-2010 than in the next period 2010-2020. Two opposite aspects cause these trends, i.e. the technological improvement, due to the passage from Euro 0 and 1 to Euro 4, and the increase in vehicles numbers. The first one influences in particular the reduction of NO_x and CO, the second one, especially in the case of diesel vehicles, the increase of PM10 and CO_2, which depend more on fuel type than on the Euro class.

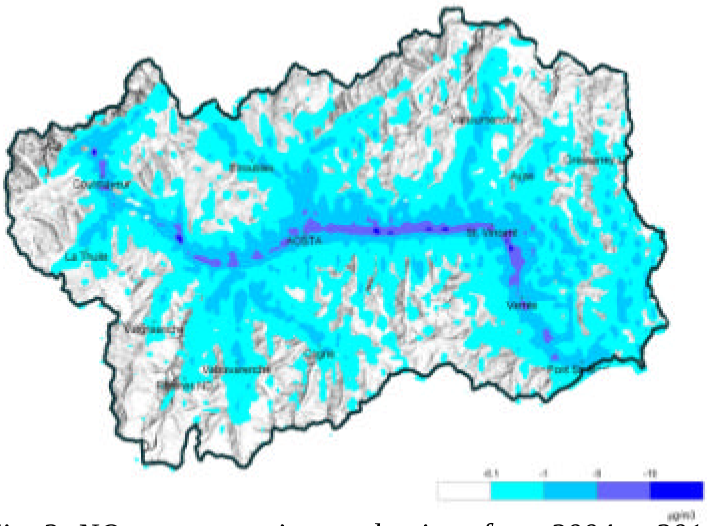

Fig. 2; NO_2 concentrations reductions from 2004 to 2010.

These scenarios clearly suggest that it is important that the technological improvement is accompanied by traffic reduction measures, especially for heavy duty vehicles and diesel cars. Using the SPRAY code, nitrogen dioxides concentrations have been calculated in the whole region from the emissions related to every type of source.

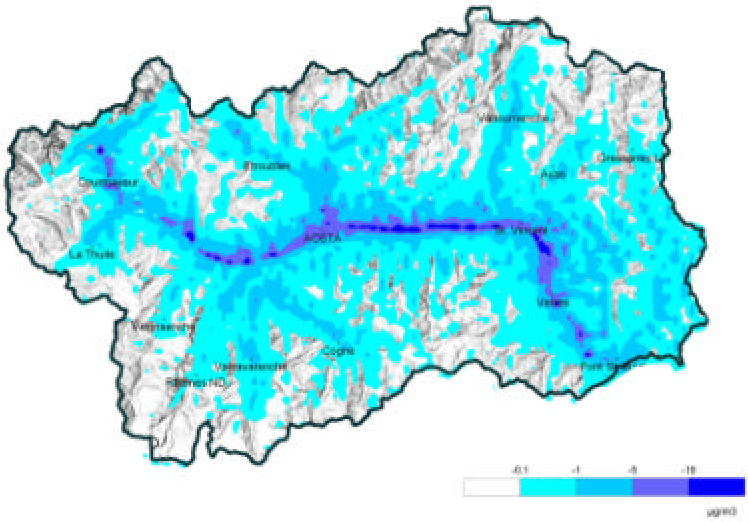

Fig. 3; NO_2 concentrations reductions from 2004 to 2020

Figures 2 and 3 show the NO_2 concentrations reductions from 2004 to 2010 and 2020; maximum reductions are in the bottom of the valley, where the international motorway network going to France is located.

SCENARIOS 3 AND 4: TRAFFIC REDUCTION IN AOSTA TOWN

The previous scenarios improve the extra urban traffic, but they yield a small reduction only in the improvement area for our region i.e. the main town Aosta.

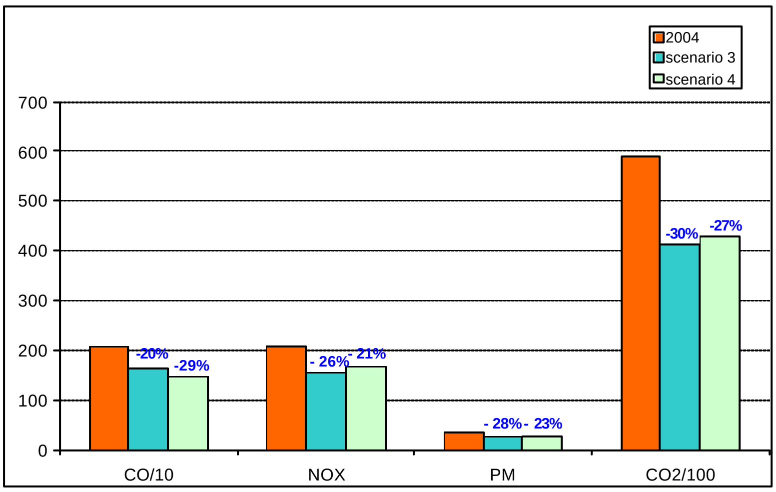

Fig. 4; Traffic emission reductions in Aosta town (tonnes/year).

In order to analyse this area, two emission reduction scenarios for urban traffic were built, using actions concerning mobility, public transport and commercial traffic:

- scenario 3: reduction of 1/3 in car number and of 2/3 in light duty vehicle number;
- scenario 4: reduction of ½ in car number.

Starting from vehicle numbers for 2004, their reduction and the subsequent emissions have been calculated (see previous figure 4).

Scenario 3 leads to a considerable reduction in emissions of nitrogen oxides, PM10 and carbonic dioxide, thanks to LDV reduction, whereas scenario 4, involving only cars, achived a lower reduction of carbon monoxide.

As for concentrations assessments (figure 5), reductions can be observed close to the high traffic streets of Aosta.

Scenario 3 appears to be more successful, as it ensures a stronger reduction of the two pollutants which currently exceed the allowed limits: particulate matter and nitrogen oxides. Moreover, the improved area is larger in scenario 3 than in scenario 4.

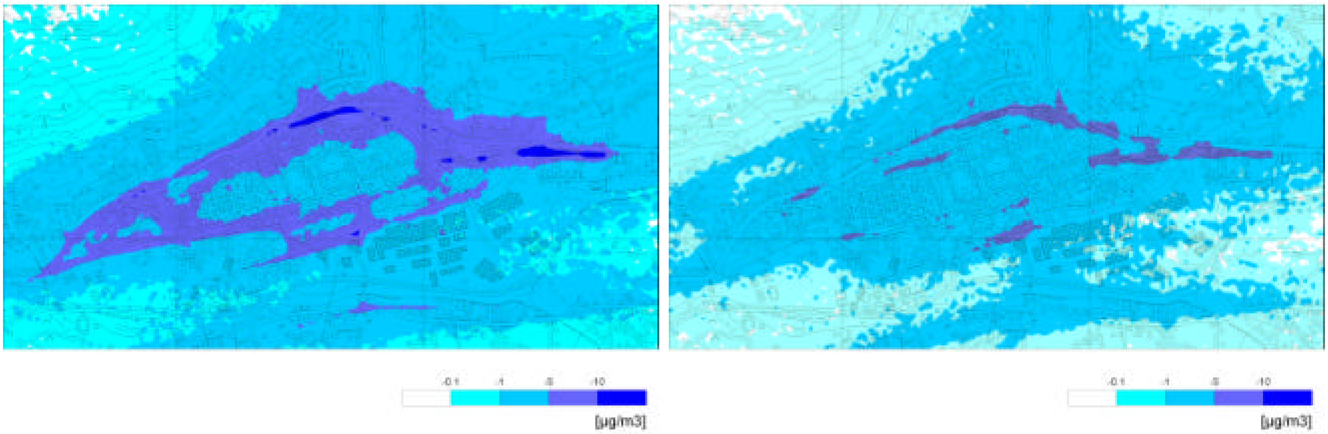

Fig. 5; NO_2 concentrations reductions from 2004 to 2010 and from 2004 to 2020 in Aosta town (traffic scenarios 3 and 4).

Finally, scenario 3 is better than scenario 4, because it can be more easily applied as it concerns not only one, but two vehicle typologies.

SCENARIO 5: INDUSTRIAL EMISSION REDUCTION

Industrial activities are the second nitrogen oxides source in the Aosta town and affect air quality, especially in the South-Eastern part of the town, due to the typical meteorological conditions in the Aosta basin.

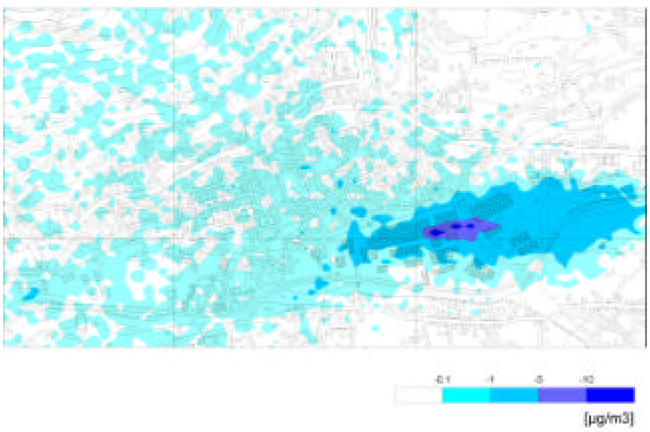

Fig. 6; NO_2 concentration reduction in the industrial scenario.

The studied scenario was based on emission reduction of 20%, i.e. from 285 tons per year of nitrogen oxides in 2004 to 228 tons.

This variation allocated to the chimneys caused a reduction of the pollutant concentrations in the industrial area and East of it (figure 6). Although significant, this reduction alone (estimated to be in the 5 - 10% range) is not sufficient to guarantee the respect of the air quality limits. The best results can be in fact achieved by combining all the measures suggested in the Plan, involving traffic as well industrial activities.

CONCLUSIONS

Table 2 shows the scenarios effectiveness in terms of variations of NO_2 annual average concentrations in three urban monitoring stations: Piazza Plouves (urban centre), Mont Fleury (suburban area) and Quartiere Dora (close to the industrial area).

Table 2. Scenarios effectiveness evaluation in terms of NO_2 annual average concentrations: absolute values (µg/m3) and relative variations.

Scenarios	Piazza Plouves		Mont Fleury		Quartiere Dora	
Annual average measured for 2005	39.0		28.0		35.0	
Scenario 1	33.5	-14%	19.9	-19%	31.5	-10%
Scenario 2	32.0	-18%	21.3	-24%	30.8	-12%
Scenario 3	31.6	-19%	24.6	-12%	32.6	-7%
Scenario 4	33.9	-13%	25.5	-9%	33.3	-5%
Scenario 5	39.0	0%	27.7	-1%	33.3	-5%
Scenarios: 1+ 3	27.2	-30%	20.0	-29%	29.3	-16%
Scenarios: 1+3+5	27.2	-30%	19.8	-29%	27.8	-20%
Scenarios: 2+3	25.9	-34%	18.7	-33%	28.6	-18%
Scenarios: 2+3+5	25.9	-34%	18.4	-34%	26.9	-23%

As can be seen from the table, although the highest reductions can be achieved through the synergical action of all the measures considered, values significantly below the allowed limits are obtained by each of the first four scenarios.

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